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A PHILOSOPHICAL ACCOUNT OF

W O R K



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Endeavouring to set forth the several GRADATIONS
Remarkable in the

MINERAL, VEGETABLE, and ANIMAL
PARTS of the CREATION.

Tending to the Composition of a SCALE of LIFE.

To which is added,

An Account of the State of GARDENING, as it is now in Great Britain,
and other Parts of Europe: Together with several new Experiments
relating to the Improvement of BARREN GROUND, and the
Propagating of TIMBER-TREES, FRUIT-TREES, &c.

WITH MANY CURIOUS CUTTS.

*— All their known Virtue appears
Productive in Herb, Plant, and Nobler birth
Of Creatures animate with gradual Life
Of Growth, Sense, Reason — — —*

Milton.

By **RICHARD BRADLEY**,
Fellow of the Royal Society.

L O N D O N:

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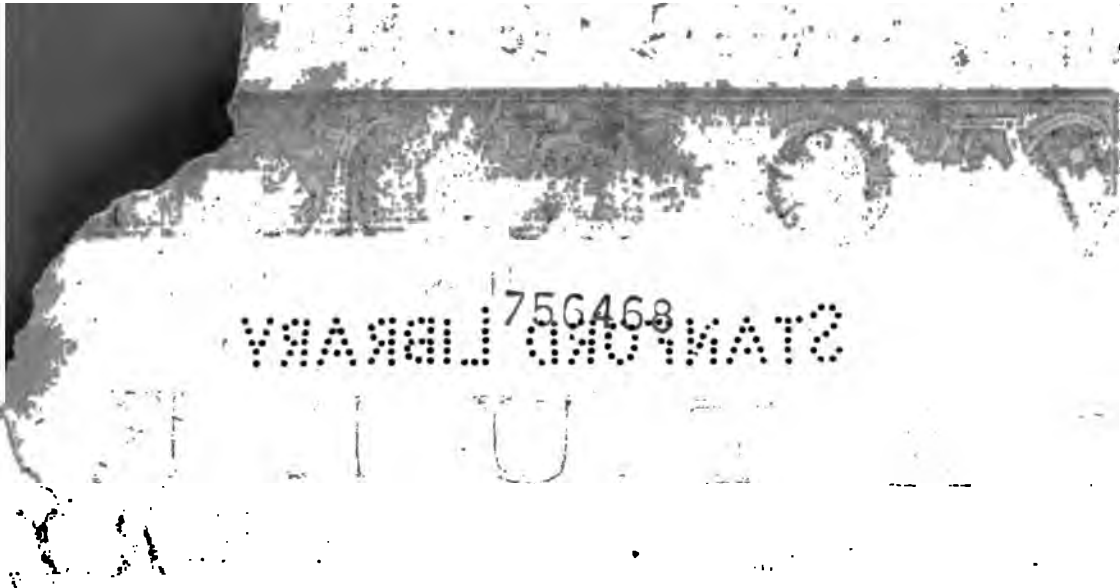
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Productive in Herb, Plant, and Nobler birth
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Milton.

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MDCCLXXI.



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To the Right Honourable the

E A R L of O R R E R Y,

*Knight of the Most Antient Order
of the T H I S T L E, &c.*

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A 2

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Memorandum, read Oviparous for Oviperous; Viviparous for Viviperous; Abricot for Apricock; and Osteography for Osteology. The other litteral Faults I desire the Reader to correct.



THE INTRODUCTION.



THE Great Mr. *Addison*, (whose Memory will ever be rever'd by the Learned and Curious Part of Mankind, for the excellent Lessons he has given to the World) among other instructive Pieces, has so beautifully represented some of the Remarkables in Nature's Works; that it is reasonable to believe a Continuance of his Life would have furnish'd us with such a Natural History, as would have been useful to Men of all Kinds of Learning.

This Learned Gentleman, in his *Spectator*, N^o 121, gives us his Opinion concerning Natural History, in the following Words.

' I could wish our Royal Society would compile a Body of
' Natural History, the best that could be gather'd together
' from Books and Observations. If the several Writers a-
' mong them took each his particular Species, and gave us a
' di-

The I N T R O D U C T I O N .

‘ distinct Account of its Original, Birth, and Education, its
‘ Policies, Hostilities, and Alliances, with the Frame and
‘ Texture of its inward and outward Parts; and particularly
‘ those which distinguish it from all other *Animals*; with
‘ their peculiar Aptitudes for the State of Being, in which
‘ Providence has placed them; it would be one of the best
‘ Services their Studies could do Mankind, and not a little re-
‘ dound to the Glory of the All-Wise Contriver.

I am proud to own in this Place, that it was Mr. *Addison* who first gave me this curious Thought, and lead me to the Composition of the following Treatise, which, however I have been fortunate in putting together, I can venture to affirm it consists of Truth so far as I have mention’d any thing upon my own Knowledge. But as the World, in Cases of this Nature, is commonly jealous of the Facts related, I have here given my Reader an Opportunity of surveying the several Curiosities I have mention’d, by directing him to those Cabinets where each respective Subject is lodg’d.

It is not to be expected, that in a Work of this small Volume, I can give a full Relation of the Exteriour and Interiour Parts of Bodies; nor can it be supposed that even it could contain the Names of every different *Mineral*, *Plant*, or *Animal* that is commonly known; for it is true (as Mr. *Addison* observes in the above-mention’d Paper) ‘ That a Natural Hi-
‘ story, after all the Disquisitions of the Learned, would be
‘ infinitely short and defective. Seas and Desarts hide Mil-
‘ lions of *Animals* from our Observation; innumerable Artifi-
‘ ces and Stratagems are acted in the *howling Wilderness*, and
‘ in the *great Deep*, that can never come to our Knowledge.
‘ Besides that, there are infinitely more Species of Creatures;
‘ which

The INTRODUCTION.

‘ which are not to be seen without, nor indeed with the Help
‘ of the finest Glasses, than of such as are bulky enough for
‘ the naked Eye to take hold of. However, from the Con-
‘ sideration of such *Animals* as lie within the Compass of our
‘ Knowledge, we might easily form a Conclusion of the rest,
‘ that the same Variety of Wisdom and Goodness runs thro’
‘ the whole Creation, and puts every Creature in a Condition
‘ to provide for its Safety and Subsistence in its proper Sta-
‘ tion.

From this useful Plan for Natural History, I have endea-
vour’d to lay the Foundation of my Building, and shall ac-
count my self happy enough, if among the Parts I have
touch’d upon I have hit on any thing new and useful: I shall
then be encouraged to proceed in my Observations and Ex-
periments, and do my Part towards raising this noble Stru-
cture. In the mean while desiring the Curious will assist all
they can, in collecting such Natural Materials, as may con-
tribute to advance so beneficial an Undertaking.







A PHILOSOPHICAL ACCOUNT of the
WORKS of NATURE.

CHAP. I.

*Of the most remarkable Appearances in EARTHS
and MINERAL BODIES.*



IN this Chapter I propose to treat of *Earths* and *Mineral* Bodies, supposing them to subsist much longer without any considerable Alteration of Parts, than any other of the Created Bodies. *Vegetables, Animals, and Insects* have respectively their Modes of Growth very different from one another, each of them undergoing visible Alterations till they are perfect; but *Earths* and *Mineral* Bodies require Length of Time to perfect themselves in their respective Stations: Which time of their Tendency to Perfection I shall, for the Ease of some of my Readers, call the Time of their Growth.

What I shall here call *Earth* is whatever Soil I find in the Superficial and Second *Strata*, such as may be used for the Propagation

gation of Vegetables; perhaps in some Cases we may even use the third *Stratum* for the Profit of Plants; but all the *Strata* below this I shall suppose are so many Beds of Mineral Matter, either in a state of Solution, or Consolidating, or else harden'd as much as they ever will be.

It would be tedious to enumerate every Particular which might be observ'd in all the Earths that are used for the Production of Vegetables; there are undoubtedly many thousand different Mixtures, which have either been made design'dly, or have happen'd by Accident. It will suffice for my present Purpose to distinguish them under three General Heads, as *Sand, Loam, and Clay*, for all Earths are in some degree or other partaking of these; and it is my Opinion that they all originally were made up of Sandy Particles, but vary'd only in their Powers, by mixing with Liquids of different qualities, (that is) such as are *Aqueous, Viscous, and Oleaginous*.

The Particles of Sand which compose Earth are not all of the same Dimensions; some are big enough to be observ'd distinctly by the naked Eye, while others are scarcely to be discern'd with the Microscope, yet every one of these Parts, however small it is, may (I suppose) lose of its Bulk and Weight, or add to both, by being expos'd to different Degrees of Heat; and so consequently when many of them are united, that united Body will still maintain so much of the natural Disposition of the Parts it was compos'd of, that a certain Degree of Heat would have the same Effect upon it, that it would proportionably have upon the least Particle of its Composition; for even a *Diamond*, which is the hardest *Gem* known in the World, will lose a Share of its Weight by means of a powerful Burning-Glass; an Instance of which we find in *Phil. Transactions* N^o 360, where in the Account of Experiments try'd with Mr. *Villette's* Burning Concave in *June 1718*, by the Reverend Dr. *Harris* and Dr. *Desaguliers*, we find that a Diamond weighing 4 Grains, lost seven Eighths of

of its Weight, an Emerald was melted into a Substance like a Turquois Stone, the *Asbestos* seem'd condensed a little in 28 Seconds, but it was then something cloudy: Mr. *Villette* says that the Glass usually calcines it. King *William's* Copper Half-penny melted in twenty Seconds, Silver Six-pence in seven Seconds and a half, Tin melted in three Seconds, Cast Iron in sixteen Seconds, Slate in three Seconds, Tile in four Seconds, and vitrified thro' in eighty, Bone calcined in four Seconds, and vitrified in thirty three, *Calculus Humanus* calcined in two Seconds, Talk began to calcine in forty Seconds; and a Fossile Shell in seven Seconds, Chalk fled away in twenty three Seconds.

N. B. Mr. *Villette's* *Mirour* is a Concave of forty seven Inches wide, and ground to a Sphere of seventy six Inches radius, so that its Focus is about thirty eight Inches distant from the Vertex of the Glass.

From whence it appears, that every Mineral or other Body, as it is more or less consolidated or hardned, is more or less subject to the Impressions made by Heat or Cold; and this I mention the rather, because I would offer the *Query*, Whether if these Parts of Sand, &c. being subject to dilate or contract, may not by means of their Pores receive a kind of nourishing or improving Juice from the next neighbouring Liquid, and by that help in a long Series of Years swell and become larger than we might suppose them at first? If this were allow'd, we might then suppose Mineral Bodies had a kind of Growth, and we might even hope to discover the Mode of Generation of Minerals or Stones; which Work, I am inform'd, the Celebrated *Malpighius* had began.

But further; take three Pound of Sand in three several Parcels, well dry'd, and make each Parcel into a Paste, the first with common Water, the second with some Viscous matter, such as a Solution of Soap and Water, or a kind of Liquid Soap, and the third with Oyl, and lay them for some time exposed to the

Sun; the Sand and Water, as it dries, will fall to pieces, or separate with a small breath of Air; the Soap and Sand will be more retentive, and will not separate without some difficulty; and the Oyl and Sand will be baked so hard, as to require a considerable Force to divide its Parts from one another.

I suppose then that the three several Soils I have mentioned, viz. *Sand*, *Loam*, and *Clay*, are all of them composed of Sandy Particles, but differently mixt with Liquids analogous to those I have mentioned, and by that means are more or less binding.

All kinds of *Sandy Soil* are nourish'd with *Watery* parts.

Loam mixt with some *Viscous* Liquid, and therefore more binding than *Sand*.

Clay mixt with *Oily* Parts, and therefore more binding than *Loam*.

And I the rather believe this, because Water easily penetrates the *Loam*, and the viscous Parts in it may be wash'd away without difficulty; but *Clay* is more stubborn, and resists the Water, which seems to demonstrate that the Parts it is composed of are bound together by somewhat *Oleaginous*.

Chalk I take to be a certain degree of *Clay* whose Parts are more ripened; and *Marle* to be some undigested Matter, which length of Years would ripen and consolidate.

I observe that neither Earths or Minerals are always constant, with regard to the Depth and Situation of their *Strata*, as we may see in several Accounts sent to the Royal Society by some of their Ingenious and Learned Members. In *Phil. Trans.* N^o 336, Mr. *Fettyplace Bellers* gives us the following Account of the *Strata* of Earth, Stone, &c. found in a Cole-Pit at the West End of *Dudley* in *Staffordshire*.

The first *Stratum* immediately under the Turff, a Yellowish Clay four Foot thick.

The second, A Blueish Clay, five Foot thick.

The third, A Blueish hard Clay, called *Chinch* by Miners; it is one of the certain Signs of Coal. This *Stratum* is twenty four Foot thick.

The fourth, A Blueish soft Clay, nine Foot thick.

The fifth, A fine-grain'd Grey Stone, which is found in some Pits only, four Foot.

The sixth, A Clay almost like the first, but whiter, twenty one Foot.

The seventh, A hard Grey Rock, seventy five Foot.

The eighth, A Blue Clunch, like N^o 3, five Foot.

The ninth, A Black Substance, call'd the *Dun Row Batt*, one Foot.

The tenth, Coal, call'd *Bench* Coal, three Foot.

The eleventh, Coal, call'd *Slipper* Coal, less black and shining than the former, three Foot.

The twelfth, Coal, call'd *Spin* Coal, more black and shining, four Foot.

The thirteenth, A Coal by the Miners call'd *Stone* Coal, like *Canal* Coal, four Foot.

N. B. *These Strata of Coal have, between each of them, a Batt as thick as a Crown Piece.*

The fourteenth, A Black Substance, call'd *Dun Row Batt*, the same with N^o 9, one Foot.

The fifteenth, A hard Grey Iron Oar, call'd *Dun Row Iron Stone*, one Inch thick.

The sixteenth, A Blueish Batt, (in which lies the following Iron Stone) call'd the *White Row*, three Inches.

The seventeenth, A hard Blackish Iron Oar, lying in small Nodules, having between them a white Substance, and therefore call'd by the Miners *White Row Grains*, or *Iron Stone*, one Foot three Inches.

The eighteenth, A hard Grey Iron Oar, with some white Spots in it, call'd the *Midrow Grains*, two Inches.

The

The nineteenth, A Black fissile Substance, call'd *Gublin Batt*, two Foot.

The twentieth, A hard Blackish Iron Oar, with white Spots in it, call'd the *Gublin Iron Stone*, nine Inches.

The twenty-first, A Batt, in substance much like that in N^o 19, one Foot six Inches.

The twenty-second, A hard Grey Iron Oar, call'd *Cannoc*, or *Cannoc Iron Stone*, six Inches.

The twenty-third, A Batt somewhat harder than N^o 21, one Foot.

The twenty-fourth, A dark Grey hard Iron Oar, call'd *Rubble Iron Stone*, six Inches.

The twenty-fifth, The Table Batt, next under the Rubble Iron Stone, two Foot.

The twenty-sixth, A Coarse Coal, call'd *Foot Coal*, one Foot.

The twenty-seventh, A Black brittle shining Batt, six Foot.

The twenty-eighth, The Heathen Coal, six Foot.

The twenty-ninth, A Substance like Coarse Coal, by the Miners call'd a *Batt*, one Inch.

The thirtieth, The Bench Coal, two Foot.

The thirty-first, A Batt, six Inches thick.

This is as low as they generally dig, tho' there is a Coarse Coal under this. We are to remark, that those Substances which divide the *Strata* of Coals and Iron Oars, are call'd *Batts* by the Miners; they are generally black, consisting of a Matter peculiar to themselves, and are of a Texture nearest like Marble, tho' some of them are fissile, and others have a Substance not unlike Coal, mixt with them; it appears from hence that this Coal Mine is one hundred eighty eight Foot and a half deep.

The other Account is of the *Strata* observ'd in the Coal Mines of *Mendip* in *Somersetshire*, and communicated to the Royal Society by Dr. *Wedd*, in a Letter to him from *John Strachey*,

Strachey, Esq; and inserted in *Phil. Trans.* N^o 360, in which we may observe that the Situation of the *Strata* are very different from those in the Coal-Mine at *Dudley* above-mention'd. 'We find in the digging for Coal about *Mendip*,' says our Author, the Surface is mostly a red Soil, which under the first or second Spit degenerates into Malm or Loam, and often yields a Rock of reddish Firestone, till you come to four, five, or many times twelve or fourteen Fathom deep, when by degrees it changeth to a grey, then to a dark or blackish Rock, which they call the *Coal Clives*; these always lie shelving and regular as the Coal doth: But in these Parts they never meet with Firestone over the Coal, as at *Newcastle* and in *Staffordshire*; these Clives vary much in Hardness, in some Places being little harder than Malm or Loam, in others so hard, that they are forced to split them with Gunpowder; so likewise in Colour, the Top inclining to red or grey, but the nearer to Coal the blacker they grow; and where-ever they meet with them, they are sure to find Coal under them. The first or uppermost Coal Vein at *Sutton* is call'd the *Sinking Vein*, it is hard Coal for Mechanick Uses, but of a sulphurous Smell. About five Fathom and half (seldom more than seven Fathom) under this, lies another Vein, which from certain Lumps of Stone mix'd with it, (like a *Caput Mortuum* not inflamable) call'd *Cats-head*, they call the *Cat-head Vein*. About the same Depth again under this lies the three Coal Vein, so call'd, because it is divided into three different Coals; between the first and second Coal is a Stone of a Foot, in some places two Foot thick; but the middle and third Coal seem placed loose on each other, without any Separation of different Matter.

'Next under the three Coal Veins is the *Peaw Vein* so call'd, because the Coal is figured with Eyes resembling a Peacock's Tail, gilt with Gold, which Bird in this Country is call'd a *Peaw*. The Cliff over this Vein is variegated with Cockle-Shells

Shells, and Fern Branches, and is always an Indication of this Vein; under this again between five and six Fathom lies the Smiths Coal Vein, about a Yard thick, and near the same Depth; under that the Shelly Vein; and below that a Vein of ten Inches thick, which being little valued, has not been wrought to any purpose. Some say there is also another under the last, but that has not been proved within Man's Memory. At *Faringdon*, which lies four Miles distant from the Mines of *Sutton*, the *Strata* agree in all Parts.

Between *Faringdon* and *High Littleton* the same Veins seem to retain their regular Course; but at *Littleton* their lowest Vein is the best Coal, which at *Faringdon* proves small.

The same Veins are found again in the Parish of *Stanton Drew*, a Mile distant from *Sutton*, only at *Stanton* they have little of the red Earth or Malm on the Surface, but come immediately to an Iron Grit, or grey Tile-stone, which is a forerunner of the Coal Clives.

Now as Coal is here generally dug in the Valleys, so the Hills seem also to observe a regular Course in the *Strata* of Stone and Earth found in their Bowels; for in these Hills (I mean those only that are dispers'd between the Coal Works above-mention'd) we find on the Summits a *Stony Arable* mixt with a spongy yellowish Earth and Clay; under which are Quarries of *Lyas*, in several Beds, to about eight or ten Foot deep; and six Foot under that, thro' yellowish Loam, you have a blue Clay inclining to Marle, which is about a Yard thick; beneath this is a Yard of whitish Loam, and then a deep blue Marle, soft, fat, and soapy, six Foot thick, only at about two Foot thick it is parted by a Marchasite, about six Inches thick; it is to be noted that these Beds of Stone and Marle run horizontal, whereas the *Strata* of Coal run slope-wise. As it is very well represented in a Copper-Cut prefix'd to this Transaction, which I refer my Reader to, as well as the other

other curious Parts of that Epistle, which tho' they are not immediately useful to me in this Design, are nevertheless very well worth any one's while to read.

From these two Accounts, without enumerating the several Relations we might have recourse to, we may satisfy our selves, that the several *Strata* of *Earths* and *Minerals* in Coal Mines, found in several Parts, even of *Britain*, are not always constant and agreeable one to another; and undoubtedly, when we dig for *Tin*, *Lead*, or *Copper*, the *Strata* found in those Mines do not lie regularly the same in one County that they do in another: And even the hardest of them, at this Day, were once no more than thin Mud little denser than Water; so that Bodies of no more weight than Shells, or Teeth of Fishes, would subside themselves down to the bottom, or lodge themselves in it: We have Instances enough to prove this from the many kinds of Shells, Fish-bones, Bits of Plants and Animals found even in Bodies as hard as Marble, and almost every Quarry of Stone; which Shells, &c. could never have been there, if the Marble and other Stones they are found in had always been of the same Hardness.

But there remains a great Difficulty to determine, (*i. e.*) the length of Time necessary to ripen each respective kind of Mud, so as to bring it to the Hardness of Marble, Freestone, Firestone, &c. But if we examine the Account sent to the Royal Society about four Years since, of a live Toad that was cut out of the middle of a Block of hard Stone, we may reasonably imagine, that sort of Stone could not be longer than an hundred Years, from its state of Mud, to the time it was taken out of the Quarry, without we suppose that a Toad can live longer than an hundred Years. We have indeed an Instance of the speedy consolidating of Sand, Lime, and Water made into a Mud or Mortar; and whether there may not be found some kind of Liquid to mix with Sand and Lime, which will make them more bind-

ing, and expedite their hardning, I leave to the Architects to consider; but they must take this Thought along with them, that even some Waters are more petrifying than others; and that some kinds of Stone lying near the Surface are very hard when they are dug, but decay in a few Years when they are exposed to the Air; while others, which are softer in the Quarry, grow hard and firm presently after they are taken out of it.

Dr. *Stukely*, F. R. S. has very judiciously given his Opinion of this Matter, in a Letter to the Royal Society, concerning an Impression of a Skeleton of a large Animal in a very hard Stone, call'd a *blue Clay Stone*, supposed to be dug out of the Quarries near *Fulbeck*. That Gentleman gives us, among other curious Remarks, the following Article: 'Sir *Isaac Newton's* Doctrine
 ' of the Attraction of the Particles of Matter, according to the
 ' quantity of its Solidity, Proximity, and Surface, especially that
 ' it is infinitely greater in the point of Contact, upon which de-
 ' pends its Cohesion, and all the Varieties of Physical Action,
 ' will easily direct us to a Notion of Petrification. We learn how
 ' a proper degree of Heat or Cold, Moisture, Motion, Rest and
 ' Time promote this Principle, from the common Experiments of
 ' Chrystallization, and freezing even before the Fire, and in ma-
 ' ny Chymical Mixtures. Whence we cannot be ignorant of
 ' Stone growing in the Quarries gradually, not by any fancied
 ' Vegetation, tho' there is something like it in Corals, but ge-
 ' nerally by Apposition of Parts to Parts, as is notorious in the
 ' *Fluors* of subterraneous Grots and Caverns; so that we have no
 ' reason to doubt, but what was *Clay*, *Sand*, or *Earth*, three
 ' thousand Years ago, may now be *Stone* or *Marble*, according
 ' to the proportion of Concurrence of such mention'd Causes.
 The rest of this ingenious Letter may be seen in *Phil. Trans.*
 N^o 360.

In the above-mention'd Accounts of the *Strata* we find some Veins here and there of *Metallick* matter, as *Iron Ore*, for Example:

ample: Now whether at the retreating of the Waters to their appointed Bounds after the Deluge, these *Metallick* Bodies were equal in Quantity and Perfection, as we find them now-a-days, is a *Query* worth examining: Or whether from a few Particles or Seeds of *Metallick* Bodies falling into a proper *Nidus* they encreas'd or enlarged, or else, may we conjecture? That Parts of different Forms happening to mix with one another, agreeable to some Law of Nature, might with, or without the Assistance of some proper Liquid, frame a Body, which length of time should ripen into a *Metal*; this, I think, deserves our Consideration. For my own part, I suppose that all the *Metals* now residing in the Bowels of the Earth, were not always subsisting in the state they are now in; I imagine they are abundantly increas'd since they were first created, by means of Seeds, or some method of Generating; and this, I think, is not more remote from Reason, than once the Generation of Plants was thought to be; and even from the first Principle of the Production of *Metallick* Bodies, to their most perfect State, I imagine they undergo various Alterations, and have different degrees of Ripeness, somewhat analogous to the Changes in Insectal Bodies; as for Example, Let us take out of twenty several Mines of one sort of Metal, which will yield Silver, an equal quantity of Ore, and refine every Parcel of that Ore distinctly, we shall hardly find two of these Mines produce the same proportion of Silver, or contain the same Richness one as the other, which I suppose happens, because one is in a riper State than the other; perhaps that which is now Silver, was Lead, or some other Metal, a thousand Years ago. We may yet add to this another Question, Whether a *Metal* once generated in the Bowels of the Earth may not be help'd in its Growth, or nourish'd more or less, by means of Juices (mixing with it) filtering thro' the *Strata* above it of various Textures and Depths; for I suppose, as the several neighbouring *Strata* of Earths or Stone are variously compos'd or

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placed about the Vein of *Metallick* matter, so the Juices or Liquids filtering thro' them are of different Qualities, either nourishing to the Ore when they mix with it, or destructive to it: And I rather embrace this Opinion, because it does not seem disagreeable to what the Learned Dr. *Woodward*, F. R. S. has laid down in his Celebrated *Natural History of the Earth*.

I suppose likewise, that *Gems*, which are found in the Intervals or Cavities of the several *Strata*, proceed from certain Seeds, or fecundating Particles, of their respective kinds, which mixing with the Liquids continually filtering thro' the Pores of the several *Strata*, are by degrees brought into their Beds, (*i. e.*) those Intervals amongst the *Strata*, and are there Chrystallized, and I suppose grow larger as they receive additional Encrease from the *Corpuscules*, which continually are convey'd by the Water into them, and become more ripe or perfect, as they have a longer share of time to lie there undisturb'd. From the Experiment made on the *Emerald* with Mr. *Villette's* Burning-glass, whereby it was changed into a Substance like a *Turquois Stone*, and the other Observations there mention'd, we might also conjecture, that every particular kind of *Gem* requires a different degree of Heat or Cold to bring it to its true Consistency and Colour; and then we may suppose, that while any *Gem* is first forming, and consequently in a tender State, that then a little difference from the degree of Heat or Cold it naturally required would alter its Qualities; but Nature seems to have a special Regard to maintain them always in the same Degree, without Alteration, by placing them in the Bowels of the Earth, where (if I may so say) they always breath the same constant Air without Interruption.

As for *Pebles*, *Flints*, and such like Stones, Dr. *Woodward* supposes them to have been all originally form'd and reposed in the *Strata* of Earth and Sand; and even the *Amber* too, which that curious Gentleman makes a natural *Fossile* as well as the rest;

rest; and the Reasons he gives why we find so many of them loose on the Sea-shoars, and on the Surface of the Earth, is, that by violent Washings of Rains, and by the Sea or other Water beating upon the Shores, Cliffs or Lands, the Earthy Parts are dissolved and carry'd away; but the *Pebles*, *Pyrite*, *Amber*, or other like *Nodules*, being hard, and not dissoluble, and more bulky and ponderous, are left behind, divested of their Terrestrial Covering. And indeed I do not find the Growth or Encrease of such like Bodies can be accounted for any other way, than by supposing them to have had their first Being in the Bowels of the Earth, where they might be regularly supplied with every thing necessary for their Construction and Nourishment; and again, it is so much more obvious, as we find every sort we can name, as well lying in *Strata* under Ground, as exposed upon the Shores and Surface of the Earth. And the Nourishment and Difference of Colours given these Bodies, while they were lying and growing in their several *Strata*, I suppose to be produced by a Cause, nearly the same of that which gives us the different Colours in the Leaves and Flowers of Vegetables; the several Strainers or Vessels which compose Plants, doing perhaps the same Office that the several *Strata* of Earths do to Minerals or Metals; and as the different Juices passing thro' the several Veins or Peds of Earth are alter'd by a sort of Filtration, and varied by mixing with some Mineral Corpuscles, which would be latent without such Assistance; so these Juices differently strain'd thro' the several kinds of Earth, mixing with some Vegetable Particles, which change their Qualities, produce difference of Colours in the Leaves and Flowers of the Plants they pass through.

And this is what I shall venture to mention at present concerning *Earths* and *Mineral* Bodies, which, if my Conjectures are right, have a kind of *Growth*, and even a mode of Generating and Increasing; and if once we have sufficient Proof of these, we need not scruple to allow them *Life* too, however slow it be; these

these indeed have no *Local Motion* no more than Plants; but Animals that have *Local Motion* are yet analogous to Plants in *Generation* and *Circulation* of Juices thro' their Bodies, and have *Sensation* more than Plants: Plants then want *Local Motion* and *Sensation* to be equal to Animals; but I suppose have only the Powers of *Visible Growth* more than Minerals, and of being transplanted from place to place, and yet retain the Power of *Growth*; but where must we transplant the Earth to make it grow, or improve it?

C H A P. II.

Of the CORALINE, TRUFFLE, FUNGUS, SPONGE, and such Bodies which possess the first Degree of Vegetative Life, and are seemingly the Passage between Minerals and perfect Plants.

IN the foregoing Chapter I take notice (as far as my Experience will permit) of *Mineral* and *Metallick* Bodies, that they possess a certain Share of Life, or kind of Growth, whereby they attain to distinct degrees of Perfection, as they have lain more or less time in their natural Beds; the *Stones* which I have in the last place taken notice of, have each, according to its Tribe, a Figure or Form, which distinguishes it from one of another Class; and the length of time which Nature takes to form them, gives them at least an equal share of time to remain unperishable; so it is likewise observable in *Vegetables*, that as they are more slow of Growth, so is their Remain of longer Duration; but I conceive there is not in Nature any *Vegetable Body* which can or ever had half the Durance of *Minerals*, unless *Coral* may be allow'd

low'd its place among Vegetables: And it is the different Sentiments of our great Men concerning this Subject, which gives me some difficulty in this Part of my Work. It is not allow'd by some to be more than a *Petrified Body*, while some Gentlemen of the Royal Academy at *Paris* pretend to have discover'd its *Seed Vessels*, as we may find in their Memoirs for the Year 1711. For my own part, I shall not pretend to determine so great a Difficulty, unless I had more Experience in the matter. I shall only take notice from its branch'd Figure, and its manner of fastning it self to Rocks, Stones, and Shells, that it has some Analogy to Plants; for, in the first place, if we consider the *Coralines* frequently growing upon our *English* Coasts, the manner of their rooting in *Stones* and upon *Oyster-shells*; their method of Branching, and crufted Substance, I cannot see any reason why we may not place *Coral* amongst the *Submarine* Plants. Again, as to the rooting of *Coral* in this manner, and the possibility of its drawing Nourishment from Bodies of so hard a Nature, let us look upon the *Sea-belts*, which sometimes are of that Length and Extent, that I have measured several above six Foot long, altho' the *Stones* they were rooted in did not weigh above a Pound a-piece: So likewise the *Sea-Weeds*, and *Fuci*, have not always larger Bodies to draw their Nourishment from; but indeed they may probably be assisted in their Vegetation by the frequent Returns of the Sea Water, which may serve to fill their more spongy Parts, and contribute to make 'em swell, as the Circumambient Air assists the Growth of *Land* Plants. Moreover, we find that *Coral* is of different Kinds or Species, as much as any Plant growing upon the Land; we have the Red, the White, and the Black, pretty common, besides many other more rare Sorts in the Cabinets of the Curious, where I commonly find them accompanied with *Coralines*, the *Sea-Fan*, and other such like Bodies.

The famous Cabinet of Mr. *Vincent* at *Harlem* abounds in these Rarities; as does also that of the curious Dr. *Frederick Ruysch* of *Amsterdam*, where I have seen near sixty Sorts remarkably different from each other; especially in the first curious Collection is to be admired a large Branch of the red Coral, above a Foot and half in height, of an extraordinary Value. There is indeed one thing which we may take notice of, with regard to *Coral*, that upon breaking off any part of a Branch, we discover the same Star-like Shootings as are found in the *Star Stones*; and there is seemingly wanting those capillary Vessels which run longitudinally, to convey the Sap up the Stems of Plants, nor do I find by Enquiry with my best Microscopes that they have any, which is much the same case with the Leaves of the *Aloë*, and some other kinds of *Succulent Plants*, where we cannot discover any Vessels which run longitudinally thro' them, and are therefore brittle as Glass. The famous Mr. *Leeuwenbock* of *Delft*, who was justly reckon'd the greatest Man in *Europe* for his Skill in Microscopes, has given the World a curious Account of his Observations on red Coral, in a Letter to the Royal Society, wherein, I think, are several Remarks which may greatly contribute to illustrate this Work, and help to determine whether it is more a Mineral or a Vegetable; he tells us that he has seen small Parts of the red Coral upon a little *Scollop Shell*, and upon a small Fish call a *Horn*, and was of Opinion that it did not grow on those Bodies, but was only coagulated upon the said Shells. He then proceeds to give us an Account of his Microscopal Observations, and tells us that he cut off several thin scaly Particles, both Longitudinally and Horizontally, from the Blood Coral, in order to discover the Vessels in them; he observes, that in those Parts which he had cut thro' a-cross, there ran such Fibres from the Center to the Circumference, as are found in the Roots of under-ground Fruits; but that in the other Parts he had only a feint View of some very small Orifices
of

of Vessels, and could make no perfect Remarks of them, but that it seem'd to him as if the Parts of *Coral* were made up of roundish Particles, such as some certain Fruits are compos'd of; but their Roundness was not exactly equal one to the other, but such as might best suit with the rest, so as to leave Vacuity in them; (*I suppose like the Bubbles in Froth of Liquors*) and thus, says he, the Saps which are not in the Vessels, are convey'd from one of those round Parts to the other, and so serve for Canals.

Again, he supposes that *Coral*, whilst it is growing at the Bottom of the Sea, is very soft, and that the Plants of *Coral* or their Branches being broken off by the *Coral* Fishers, the thick Ends of them may accidentally fall upon a *Stone*; or some other Substance; and by reason of their Softness, and a Glutinous Matter they are endued with, may very easily be fasten'd to the *Stone*, and then give us reason to believe it is an Excrecence from the *Stone* or other Substance we find it upon. From this last Observation, as well as the former, I do not see any reason why we may not place *Coral* among *Vegetables*; for as I've remark'd before, that the Brittleness of *Coral* may proceed from the same Cause as that does in the Leaves of *Succulent* Plants, *i. e.* the want of Longitudinal Vessels, so may the *Coral* partake of other Properties common to *Succulent* Plants, such as that if we only lay upon the Earth an Off-set or Branch of *Aloe* or *Sedum*, they will strike Root in due time without other trouble; and Shells and Stoney Substances being to the *Coral*, as the *Earth* is to the above-mention'd Plants, a broken Piece may as well take Root upon them, as the others do upon the Earth.

The *Sponge* is the next which we may consider as a Subject leading to Vegetation, and is what I believe is allow'd by all to be a Plant, tho' it is indeed seemingly imperfect, if we compare it with others; but its Vessels are so nicely woven into one another, that every part is equally supply'd with Juices as it flits,

or is driven from place to place upon the Sea; it is a Wanderer as well as the *Lens Palustris*, or *Duck Meat*, which seldom or never fixes its Roots in any solid Body, but strikes them into the Water only, from whence it receives its Nourishment. The Figure of the *Sponge* is for the most part Globular, but without any great Exactness; it is composed of Parts rather like the *Pib*, than any other part of a Plant, is wanting of Leaves, and has not either Flowers or Fruit that I can yet discover. There are relating to the *Sponge* several kinds of *Spongoids*, which are ramose or branch'd; but the Texture of their Parts are near the same with the common *Sponge*.

The next following these, and but little more perfect, seemingly, either in Figure or Parts, is the *Truffle* and the *Puff-balls*. The *Truffle* is of two Kinds, as Mr. *Tournefort* informs us, the one round, and the other of an Egg-like Figure; but the fleshy part of both these kinds is of a much closer Texture than the *Sponge*, and each of them grow commonly about six Inches under Ground in the Woods of *Italy*, *France*, and several Parts of *England*, and I am inform'd have their *Seed-Vessels* towards the Center, in the most fleshy Parts; but as yet I have not been able to discover any, but refer my Reader to the Account given of this Tribe of *Plants*, by the Curious Mr. *Geoffroy*, in the *Memoirs of the Royal Academy of Paris*, 1711. I am apt to believe the *Truffle* is not unlike the *Puff-Ball*, as to its manner of *Growth*, that is, in the first place its Flesh is pretty firm, and by degrees, as it becomes more ripe, its inner Parts change to a kind of *Dust*, as we find in the *Puff-balls*, which grow so plentifully upon Commons and other Pasture Grounds; whose *Dust* I should rather suppose to be the *Seed*, than be inclin'd to look for it in them while they are in their growing State. Of the *Puff-balls* I have likewise observ'd one sort growing in the shape of a Pear, commonly under Crab-trees.

After

After these we must take notice of those of the *Fungus Tribe*, which are yet without Caps, but seeming more constant and regular in their Figure than those we have already mention'd. There are two kinds which resemble Branches of *Coral*, they are common in the Mossy Grounds in *England*, and differ only in the Colours of Yellow and White. After them the *Cup Mushrooms* cut on one side, such as the *Fungus Sambucinus*, or that which is found growing about the Roots of the *Elder-tree*, and some others nearly ally'd to it, which are of an *Orange Colour*.

Next follows those kinds of *Fungi* with *Stems* and *Caps*, which vary their Figures as they become more replete with Juices; these begin to shew us some Parts, which we may naturally expect to find in *perfect Plants*, as *Roots* and *Vessels*, which run longitudinally, and compose the *Stem*, from whence the *Cap* receives its Nourishment till it is fully explain'd, as may be easily discover'd in the common *Mushroom* or *Champignon*, without the help of a *Glass*, as well at its first Appearance in the *Button*, as when its *Cap* is fully spread; the *Chives* within side of the *Cap* have been by some taken for the *Seed*; but I do not find, with the greatest Care, they can ever be made to Germinate.

As to the *Champignon*, which is so much esteem'd for its excellent Flavour and delicious Relish, it is propagated with great Facility in the Gardens about *Paris*; but the Gardeners there have no regard to the *Chives* which I have before mention'd; nor do they believe there is any such thing properly as *Mushroom Seed*, but chiefly rely upon the manner of making Beds for them, and placing here and there in those Beds small pieces of Moldy Soil, found commonly in old Dunghills, which is accounted better, as it abounds with white Cobweb-like Veins running through it. And it is observable that the Moldy Soil I mention, after lying three or four Days in the Bed, becomes as it were a Leaven to the whole, by shooting out its Cobwebs over the greatest

part of the Surface, and at length runs into Clusters of small white Knots, which come in the end to be perfect *Mushrooms*. To make these Beds, they provide three or four Cart-loads of Horse-dung, well clear'd from the Straw, and toss it up in an Heap to lie for fifteen Days; then they mark out their Bed three Foot wide, and of that length as may employ the Dung to lie near a Foot and half thick, laying the Sides sloping, in such a manner, as that the Top of the Bed may be brought to a Point or sharp Edge, like the Ridge of a House, when it comes to be raised three Foot high, which must be done with Dung, prepar'd like the former fifteen Days, after the first making or laying of the Bed.

Immediately after the first Layer of Dung is wrought it must be cover'd, the Top and Sides with Horse-litter to lie upon it undisturb'd, till we lay on the second or last Course of Dung, and then the whole Bed must be coated an Inch thick, with fine Earth, and beat down gently with a Spade, having a strict regard where the Line runs between the two different Layers of Dung, along which there must be bury'd about an Inch deep some small pieces of the Moldy Soil as big as *Walnuts*, at a Foot distance, and then the whole carefully cover'd with Horse-litter; from this Management we may expect a large Quantity of *Mushrooms* in a Fortnight after the Bed is compleated, and will continue to produce every Day for a Month or five Weeks.

In the gathering of this Dainty, the *French* Gardeners always take care to pull them up with their Roots, pressing the Earth down gently upon the place they draw the *Mushrooms* from, and covering it with the Litter immediately; they are likewise very curious to observe, that no broken part of a *Mushroom* be left on the Bed, which would breed Worms, and destroy the young Knots of *Buttons*, which are coming forward. In the Winter they lay up great Parcels of the Moldy Soil in dry places, for their Use at different times; and they have this regard to the
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Fig. I.



Fig. II.



Fig. III.

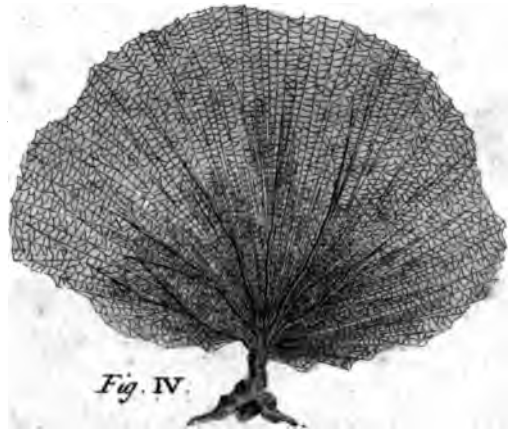


Fig. IV.

making of their Beds in the Summer, that from *May* till *September* they lay the Foundations of them eight or ten Inches below the Surface of the Earth.

Of these *Cap Mushrooms* there are some more substantial, others more fugacious, some edible, others poisonous; but to take them together they are a very numerous Family. The curious Mr. *Dandridge* (to whom I've been obliged for many Notes and Observations mention'd in this Work) has now by him the Paintings or Figures of above a hundred Sorts, which he has collected in *England*; and I am perswaded that there is hardly any Nation which does not afford as many different kinds in proportion, considering the Drawings I have seen in the curious Cabinets abroad. The Times of their natural Growth, is in the Spring, and in the Autumn.

We may note, that the Moldiness upon Liquors; and such as appears upon Confections and Pickles that are damaged, is of this Tribe: They are multitudes of small *Fungi* or *Mushrooms*, which are of that quick Growth, that in about fifteen Hours one single Point will spread a quarter of an Inch over the Surface, as I have observ'd with the Microscope.

Explanation of the Figures relating to this Chapter.

PLATE I.

Fig. I. *A Branch of the Red Coral.*

Fig. II and III. *Branches of Coralines.*

Fig. IV. *The Sea-Fan.*

PLATE II.

Fig. I. *Truffle.*

Fig. II. *The Button of the Mushroom, with its Plant fully perfected.*

CHAP.

C H A P. III.

Of PLANTS and SUPER-PLANTS, what is most remarkable in them.

THE former Chapter gives us an Account of those Vegetables which seem to be the most imperfect, as to their want of Parts; but they are indeed more speedy in their Growth than those Plants which have the usual Ornaments of Leaves, Flowers, and Fruit, or such as we shall find treated of in this Chapter. *Mushrooms* however are certainly perfect as to themselves; but the more common Knowledge of *Trees, Herbs, and Shrubs*, may give us room to think, that whatever Vegetable is wanting of the Ornaments these possess is not perfect. For my own part, I think it no small Pleasure that Nature is so extensive and variable in her Works, that a bare Discovery of them is more than the whole World can compass; and that the Mind of Man, which naturally loves Novelty, has the grateful Opportunity of being placed in the midst of such a boundless Variety. With regard to Life and Growth, the Unskilful are apt to judge, that Parts of the same Kind must equally reside in all created Bodies; but if I may venture to give my Notion concerning that case, it is, that what every Vegetable or Animal is wanting of half the Parts or Ornaments that we find in others, those seemingly *Imperfects* have a double Power of acting from every Part they contain, so that two Parts in them perform as much as four in the others; which may perhaps be the reason that *Mushrooms* are of quicker Growth than those *Plants* which we stile the most *Perfect*.

The *Plants* which I think most properly follow the Tribe treated of in the foregoing Chapter, are first, the *Rush* Kind,
or

or *Juncus*, of which there are many sorts, some larger, others lesser, which chiefly distinguishes one Kind from another, all of them consisting of green spiral Stems, which respectively bring forth Bunches of Flowers that end in Seed, but have no Leaves; they may be rather accounted *Amphibious* Plants, than Inhabitants of the Waters, seeing that they grow as well on the Land, if it be tolerably moist, as in the Waters.

These may be succeeded by the *Echinomelocactus*, or *Melon Thistles*, which are *Plants* without Leaves, and are only guarded with *Thorns*; the *Melon Thistles* never branch, unless they are cut, as I have observed in two kinds of them: the large sort which comes commonly from *Newis* and *St. Christophers* in the *West-Indies*, by losing its Top or Crown, puts forth young Heads, which may be taken off and planted for Increase; and so likewise the smaller kind, which comes from the *Cape of Good Hope*, will do the same; the first of these I have seen in the state I mention, in the Royal Gardens at *Hampton-Court*, and the latter in the Physick Garden at *Amsterdam*, from which Place I got several young Plants. It is remarkable, that in both these the Blossoms barely appear through the Skin or Covering of the *Plant*, and the Fruit always remains hid within the *Plants* till it is full ripe, and then bursts forth on a sudden, which is not common in other *Plants*. These two are described in Mr. *Ray's Historia Plantarum*, and in the *Hortus Lugduno Batavus*, and are ready Engraven for my History of *Succulent Plants*.

The next following is the *Torch Thistle*, a *Plant* of an extraordinary Face; it is wanting of Leaves, but in other Respects coming nearer the Perfection we look for than the former; these flinging out their Branches freely; they are all guarded with *Spines*, and bear large Star-like Blossoms, which do not open till the Fruit is full grown, after the manner of the *Opuntia* or *Indian Fig*: The largest kind of them is that which
we

we have so common in our Green-houses in *England*, and is engraved in the first Decade of my *History of Succulent Plants*; this I have seen near twenty Foot high in the Royal Garden at *Paris*; and in the Royal Gardens at *Hampton-Court* there is another sort with a white Rind or Skin, which, like the former, grows upright, but with less Luxuriance. The first of these I call *Cereus erectus Maximus Americanus hexangularis, flore albo radiato*, or, *Great Upright Torch Thistle*: The second, *Cereus Americanus Octangularis Spinis albicantibus*, or, *Great White Torch Thistle*. At the Physick Garden at *Amsterdam* they have three or four different Kinds of the *Upright Cereus*, which I have not seen elsewhere; of this Tribe there are likewise some *Creepers*, which are jointed and run upon the Ground: Their Thorns are commonly small and tender, and the young Shoots are for the most part furnish'd with voluntary Roots, which lay hold of the *Earth* or *Barks* of Trees as they happen to fall. One sort has a *Triangular Stem*, the other has its *Stems* six rib'd. The first is engraved in my first Decade of *Succulent Plants*, the other I design for the third; to these we may join the *Euphorbium*, and some other *Tythymals*, which are yet without Leaves; they shoot their *Stems* upright, are guarded with *Thorns*, and differ from the foregoing *Plants*, in having a Milky Juice, and Flowers and Fruit of small regard. Dr. *Comelin* has given us very good Cuts of many of them in his *Hortus Amstelodamensis*.

The *Plant* next following the *Euphorbium* is the *Opuntia* or *Indian Fig*, which is the first *Plant* that attempts to make Leaves, but in such a manner as may easily slip the Observation of the Curious. Mr. *Rand*, F. R. S. a most ingenious and learned *Botanist*, was the first who informed me of them; they appear only upon the young *Stems* whilst they are perfecting their Growth, and afterwards are supplanted or followed by Knots of *Spines*. Of this Tribe I have about thirteen sorts growing in *England*, which I design to describe in my *Decades of Succulent Plants*; they are
all

all very full of Juice and Pulp, shooting *Stem* out of *Stem*: 'Tis from one of these Kinds that the *Indians* gather the *Cochineal*, which I shall mention at large in its place.

The *Fig-Tree* may next follow the *Opuntia*, as the Fruit is always perfected in its Parts before the Blossom is to be found. What I mention concerning the Blossom of the *Fig*, or manner of its Flowring, I have not my self yet seen; but take the Account from my Friend Monsieur *Geoffroy*, of the Royal Academy at *Paris*, who has given a large Description of the Flowers of it in the *Memoirs of the Royal Academy of Sciences at Paris, for the Year 1712*. That Gentleman, upon the foot of what Mr. *Moreland*, my self, and some others, have advanced, concerning the Generation of *Plants*, or the manner of setting their Fruits, has given a large Account of such Parts of Blossoms in the *Fig* as are necessary in Nature to perform the Office of Generation; he tells us, that all the Parts required to do this Work are within the Fruit of the *Fig*, those which are Female lying towards the bottom of the Fruit, and the *Apices* or Male parts, which produce the *Farina fecundans*, are situate towards the Top; he has given us very good Figures of them in general, and in particular, both from natural View, and with the Microscope, which I shall leave my Reader to examine; and in the meanwhile, as I have had occasion to mention somewhat relating to the Generation of *Plants*, I shall entertain my Reader with a curious Essay upon that Subject, which was communicated to me in the Year 1719, by that excellent Physician Dr. *Antoine de Jussieu*, Professor of *Botany* at the King's Gardens at *Paris*, Entitled,

The Analogy between Plants and Animals, drawn from the Difference of their Sexes.

THAT *Plants* and *Animals* are analogous, we may believe, if we only consider the manner whereby they receive their Nourishment.

rishment. That sort of Life which the antient Philosophers observ'd in *Plants*, was accounted by them so nearly the same with that in *Animals*, that they did not scruple to call it a *Soul*, but has since been more reasonably term'd *Vegetation*.

The Comparison which has been made between the Structure and Use of the *Bark* of *Plants*, with the *Skin* of *Animals*; of the *Tubes* through which the *Sap* is convey'd through the *Trunk* to the *Extremities*, with the *Arteries* and *Veins*; the Resemblance of the Ramifications of those Channels, with the *Blood-Vessels* and *Lymphaticks*, has given Occasion to *Cesalpinus* and other illustrious Authors amongst the Moderns; who have study'd the *Anatomy* of *Plants*, to establish this System.

We may yet advance this Opinion much farther, if we consider the Nature of *Plants*, and how they may be distinguish'd as *Terrestrials*, and *Aquaticks*, and thereby agreeing with the *Animal* Kingdom. We may also compare the Solidity and Duration of *Woody* and *Fruticose* *Plants*, with the Strength and Length of Life in *Quadrupedes*. We may likewise observe the Similitude between the *Capillary* and *Fungous* *Plants*, and the short Remain of such as are *Annual*, with the Imperfections attributed to *Insects*, and the Shortness of their Lives: And to this we may add another Remark, That among *Plants* there are two sorts of *Aquaticks*, which, like Fish, are either distinctly Inhabitants of the Salt or Fresh Waters.

As there are *Amphibious* *Animals*, so is the *Vegetable* Kingdom also furnish'd with *Plants* that have Parts which live as well out as within the Waters.

But as these general Observations, which are founded upon the Structure of the *Organs*, and upon the Mode of *Growth*, have been already discuss'd by so many Physicians, that there is no room left for Doubt, I shall make it my Business to establish another kind of Agreement betwixt *Plants* and *Animals*, by more particular Observations, drawn chiefly from the Diversity of
Sexes,

Sexes, and from the Conformity and Uses of those Parts which are to be distinguish'd in them, for the perpetuating their Species.

It appears that the Antients had some Notion of this Distinction of Sex among *Plants*, as we find in their Writings that some have given the Quality of Male, others of Female, to certain *Vegetables*; but the more I have taken pains to examine into the Reasons they had to establish this difference of Sexes, so much the more I find them out of Reason; especially when I discover that they have given the Feminine Character to some *Plants* for the sake of their beautiful Flowers, or from the Port or Appearance of the whole *Plant*, as in the *Peony* and some others; or else they had establish'd the Masculine Gender from the Conformation of the *Roots, Fruits, or Seeds*, as they were nearer the Resemblance of the Male Parts of Generation in *Animals*, as in the *Orchis, Mercury, Hemp, &c.*

But the Chief of the modern *Botanists, Malpighius, Grew, Ray, and Camerarius*, have greatly improv'd upon the Hints given by *Cesalpinus*, by marking out to us in a particular manner the Distinction of Sexes, in the Description of certain Parts which do those Functions.

I shall not in this place enter upon the late Proposition of Messieurs *Geoffroy* and others, who in the Description they give us of the several Parts of a Flower, tell us, that the *Dust* which falls from the *Apices* of Flowers is the *Germ* of the *Plant*, or *Embrion* of it, since this System is subject to the same Difficulties with that of the Generation of *Animals*, supposed to be affected by the *Worms* or *Animalcules* in the Male Seed.

Nor do I pretend to assign any Reason why Nature has observ'd so much Regularity in so many different Figures, as we find in the *Farina* of each respective kind of *Plant*, with the help of *Microscopes*, since Dr. *Grew*, who was so careful in his Observations of this Nature, and Monsieur *Geoffroy*, who is a dili-

gent Follower of that ingenious *Englishman*, have neither been able to find them out.

I shall only take upon me to compare the Exteriors of *Plants* with *Animals*, as far as it regards their Sexes, wherein this Difference of Sex in *Plants* consists, and the manner of observing it.

As the *Flower* is that part of a *Plant* which contains the *Organs* for its Generation, it is necessary to determine what Idea we ought to have of it, and not to fall too hastily into the enormous Opinions of some who believ'd with *Malpighius*, that their most essential Parts were no more than *Viscera* appointed for separating the Excrementitious Juices.

I am of Opinion, that what we ought properly to call the *Flower*, is the Assemblage of little Threads, to which the *Botanists* have given the Name of *Stamina*; and are terminated at their *Tops* by *small Caps* or *Purses* call'd *Apices* or *Chives*, which generally have double Openings, from whence flies out the fine *Dust* which ripen'd in them.

The *Stamina*, which I have just now mention'd, are either encompass'd by a single or double Furniture, either of one, or of many Pieces, consisting of one or of various Colours, which have hitherto been call'd *Leaves*, but may rather bear the Name of *Petals*, to distinguish them from the common Leaves of *Plants*, which are generally green, as well as those which serve for an outward Coat to the *Petals*, and known by the Name of *Calyx* to the Flower.

These *Stamina* encompass, for the most part, a Body of a different Figure, either single or compos'd, which is either the *Embryo* of the Fruit, or a *Tube* terminating like a Trumpet, to either of which the Name of *Pistillum*; or *Pistil*, is indifferently given.

This Description I conceive is exact and full enough to give us a quite different Idea of the *Flower* than what we have hitherto

to receiv'd, and may oppose the vulgar Opinion that every *Body* of various-colour'd Leaves is a Flower or Blossom; instead of which, the curious Observers of Nature cannot miss the Observance (besides the *Petals*) of all the other Parts which we have just now mention'd; and from the Instant they behold them, must of necessity perceive their Uses from their Structure and Disposition, but more especially when they have Opportunity of observing their several States and Changes at different Times.

We may conclude then that the Secret of Generation is neither to be found in the Root, Trunk, or Leaves of a *Plant*, but only in the Garniture of those *Organs*, which we have observ'd the *Flower* is compos'd of: Since we do not find in any other part of *Plants* those *Organs* which so well agree with the Parts of Generation in *Animals*, or are so useful and necessary to perpetuate their Species. It seems as if Nature, who has hid from us her manner of Working in the Generation of *Animals*, is more inclin'd to open that Mystery to us in the *Vegetable* Kingdom, since the Means she makes use of, with regard to Generation of *Plants*, is more open, and may be more easily observ'd.

In effect, what can more resemble those *Organs* which constitute the Male-Sex in *Animals*, than those which characterise the same in *Plants*? What Agreement is in their Functions! Those little *Caps* which make the *Chives* of the *Stamina*, the *Farina* which they enclose, and is so exquisitely prepared as a proper Matter for fecundating the *Germe*; and again, those Trumpet-like *Tubes*, which are stiled *Pistils*, situate in the Center of the *Stamina*, for the more easy Reception of the *Dust*, which is the Off-spring of the *Apices* or *Chives*, the Springs which open them, and the manner of their flinging abroad this prolifick *Dust*: Do not these sufficiently set forth the beautiful Simplicity which Nature observes in her Works?

If we could find modest Terms to express the Care and Precaution which Nature takes to succeed in her Work of Generation
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in *Animals*, what Agreement and Uniformity should we not find with that she makes use of in the Generation of *Plants*? The Usefulness of the *Petals* which encompass the *Apices* to press them towards the *Pistillum*, so that their *Dust* may fall in great Abundance into it; as likewise how necessary they are to protect those tender Parts from the Injury of the Wind, may still afford us fresh Matter of Admiration.

It is easy to judge, from the Function of the *Pistillum* which receives this *Dust*, that it does the Office of the Parts of Generation in the Female *Animals*; and that what we have before observ'd, as far as the Intromission of the *Dust* into the *Pistillum*, agrees well enough with the Conception of the *Fœtus*.

The Nourishment and Growth of the *Embryo* Seed after its *Germ* is made fecund, is agreeable to the Growth of the *Embryo Animal*; the Fruit which encloses it, whether it be *Membraneous*, *Ligneous*, &c. or whether it be in the Form of a *Capsule*, *Cod*, or *Siliqua*, or is divided into few or many Cells or Lodgments, that Fruit (as *Malpighius* observes) serves as a *Matrix* to the Seed.

From this Description of the Parts of a *Flower*, and the Observations upon their Uses, we may draw two Consequences.

The first is, That those Parts in *Plants* which may be term'd *Flowers*, are those which perform the Office of Generation.

Secondly, That after the same manner that in the *Animal* World we distinguish between the *Males*, *Females*, and the *Androgynous*, we likewise discover those Distinctions of Sexes in *Plants*, which *Dr. Grew* has already touch'd upon.

We may then conclude that a *Plant* may be termed *Male*, when its *Stamina* do not encompass any *Pistil* or *Stile*, or that the *Stile*, if it has any, is barren, or does not enclose an *Embryo* Seed: Of this kind, are those Strings or Bunches of Flowers which we call *Catkins*, or *Julii*, and the false Blossoms of *Hops*, *Hemp*, *Mercury*, and some others.

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On the contrary, the *Female* is easily known by its *Pistils* or *Stiles*, which are not encompass'd by *Stamina*, but only guarded with *Petals* or other *Membranes*; and yet are fecundated by the *Dust* of *Male* Flowers, which either grow upon the same *Plant*, or upon others of the same *Race*. This *Fecundation* is done by the help of the *Wind*, which conveys the prolifick *Dust* into the *Tubes* of the *Pistils*, when they are advanced to a fit State to receive it, as it is observable in the *Walnut*, *Hazle*, *Alder*, *Willow*, *Coniferous* Trees, and *Gourd* kind. *Malpighius* observ'd these two Distinctions in the *Flowers* of the last mention'd *Tribe*, as we may remark, by the *Figures* he has given of them in his *Anatomy of Plants*.

The certain Mark by which we may discover the *Androgynous* Flowers, is the ranging of the *Stamina* about the *Pistillum*, whose *Base* or *Body* becomes a *Fruit*; since we have already remark'd, that the *Stamina*, which are the *Male* Parts, will fecundate the *Pistils* in the same *Flower*, which Part we have observ'd is found only in the *Female*. There is this only Difference between the *Plants* and *Animals* that are *Androgynous*; *Plants* accomplish their *Generation* in themselves without the help of another Individual of the same *Tribe*; and the *Animals*, altho' they are endow'd with *Organs* agreeable to both Sexes, are yet obliged to seek for one of their own *Race* to couple with. *Plants* for the most part bring *Flowers* of this last Species, (that is to say) such *Flowers* as end in *Fruit*.

This Discovery is the Fruit of those Observations which have been made in the *Anatomy of Flowers and Fruit*, since it has been judg'd necessary, that those Parts of *Plants* were the most proper to establish their Characters; and 'tis not to be doubted but that *Time* and *Industry* may disclose to us *Organs* of the same *Uses* in those *Plants*, which have been stiled hitherto *Imperfect*, and which will no longer bear that Character when their Sex shall be determin'd.

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We cannot in common Justice refuse to give the Honour due to *John Baptist Porta*, for having first observ'd the *Seeds* in certain *Plants*, which, till his time, were esteem'd barren, as in the *Truffle* and *Mushroom*, which has since been confirm'd by the curious Remarks of Monsieur *Geoffroy*, Junior; those of Monsieur *Marchand* on the *Agaricus digitatus niger*; and those of Monsieur *le Comte de Marsigli* upon the *Lytrophyton*, in whose *Bark* he has found the *Seed*; and we begin likewise to discover them in many *Marine Plants*, but chiefly in the *Fucus*.

Monsieur *Billerer*, Professor of Physick at *Bezançon*, informs me that he has even discover'd *Seed* in a River *Sponge*, call'd *Spongia ramosa fluviatilis*.

There is room to believe, that if we were to take a little Pains to examine the *Marine Plants* at different Seasons, we might discover their *Flowers*, or such Parts as acted for them, since Monsieur *de Reaumur* and Monsieur *Michaeli*, Botanists to the Duke of *Florence*, have already discover'd certain Parts which might reasonably be esteem'd Dependants of *Flowers*.

This Distinction of Sexes being establish'd in *Plants*, is one of the most considerable Marks of the Analogy between *Plants* and *Animals*; but as it is not only by the Difference of Sexes, nor by the Use of the *Organs* of Generation, that we precisely characterise the different *Animals*; so neither must we be perswaded that these Differences in *Plants* can contribute to distinguish their several Tribes; for in many *Plants*, those Parts which mark out the Sex are not easily discover'd; and in others the *Flowers* are of so short Durance, that we are not always happy enough to find them in a right Condition for Observation.

Thus my Friend concludes his curious Observations relating to the Difference of Sexes in *Plants*, which might very properly be follow'd by the Essays upon their manner of Generating, written by my self and others, wherein there are many Particulars

lars which would render this Subject more instructive; but as they are already made publick, I shall refer my Reader to 'em in the *Memoirs of the Royal Academy of Paris, for the Years 1711, and 1712*; and my second Chapter, in my first Part of *New Improvements of Planting and Gardening, &c.* Indeed, since they have been abroad, I have had Opportunity and Time enough to make farther Discoveries, and those perhaps may not be unacceptable in this Place; as for Example: With regard to *Fresh-water Plants*, we may observe of the *Nymphaeas* or *Water-Lillies*, and the *Potamogotons* or *Pond-Weeds*, (which I have chiefly observ'd) that in their Act of Generation, or time of Flowering, the Blossoms always appear above Water till the prolifick *Dust* is ripe, and cast abroad; and as soon as that is over, and the *Pistillum* or *Rudiment* of the Fruit thereby impregnated, it bends it self downwards till it is entirely under Water, and grows ripe in that State. Again, I observe that their *Seeds* always sink to the Bottom when the Fruit is ripe enough to open it self, which shews us the Care that Nature takes to send every *Seed* to its proper *Matrix*; for these *Plants*, however their Leaves may appear to swim upon the Waters, yet their Roots have always hold of the Ground below. We must not however imagine that every sort of *Water Plant* is fastned by its Roots to the Earth at the Bottom of the Rivers or Pools where they grow: Both kinds of the *Lens Palustris*, or *Duck-Meat*, wander from place to place upon the Face of the Waters, without touching the Bottom either with their Roots or other Parts; and I think the *Water Soldiers* do the same: But that may be enquir'd into by such as live about the *Fenns* in the *Isle of Ely*, where they abound.

But it is time I return to my first Proposition and chief Design of this Work, *i. e.* to mark out, if possible, the several Gradations in Nature's Works, and what Analogy there is between one Part and another; which leads me to the Consideration of those *Plants* that are very visibly endued with all the

Parts required in *Vegetables*, viz. *Roots, Trunks, Bark, Pith, Branches, Leaves, Flowers and Fruit*; and they are of three Kinds, *Herbs, Shrubs, and Trees*.

An *Herb* is properly that *Genus of Plants*, whose *Stalks* perish every Year, and whose *Foliate* or naked *Roots* put forth every Spring their fresh *Flower-Stalks*: Of these are the *Grasses, Primrose, Auricula, Pink, Tulip, Ranunculus, Anemomy, Strawberry, &c.* and these are either *Fibrous* or *Tuberous* rooted, or else have *bulbose, apple, or knotted Roots*; and may again be distinguish'd by being *Annual, or Perennial* and *Vivaceous*. Moreover, the several Modes of Growth which Nature has distinctly given to the several kinds of *Herbs*, are well worth our Observation; the first are the *Dwarfs*, such as the *Auricula* and *Polyanthos*, or *Cowslip* Kinds, which subsist without Props or Supporters, and form their Off-sets or Increase in Clusters close about the old *Roots*: The second are *Dwarfs* likewise, as the *Strawberry* and *Violet*, which increase by sending out jointed Strings from the main *Plants*, that at every Knot take Root as they run along the Ground. The third sort is of those *Plants* which are *aspiring*, but have not Strength of Body to support themselves without Stakes or Props, which they twine round about, as the *Convolvulus, Phaseolus*, and some others, which are so strongly impell'd by Nature to twist about and embrace every thing that happens to be near them; that as the Loadstone attracts Iron to it, so have I seen *Plants* of this sort change their first Design of Growth from one Point of the Compass to another, to lay hold of Stakes that have been set a Foot distant from them. The fourth is the *Gourd*, and the *Pea* kinds, which want the Power of twining; and yet have not Strength enough to support themselves; but Nature has provided them with other Means of bearing themselves from the Ground, having furnish'd them commodiously with *Claspers*, which catch hold of every thing they can come near; these

Claspers,

Claspers, tho' they do not lay hold of the Ground about them to act there as *Roots*, yet I am of Opinion they are not only design'd for bearing up and binding the *Plants* they are related to to Props, but serve likewise to draw a kind of Nourishment from the Air, which their Mother *Plants* could not live without, and are in that respect analogous to those *Roots* which we find at every Knot of the *common white Water Ranunculus*, which in the Summer only strike into the Water, and undoubtedly receive Nourishment from it, tho' they have always a main *Root* which strikes deep into the Ground: These *Roots* are, in Appearance, like the Leaves of *Fennel*, and are so very green, that they have given us some room to believe the *Plant* had Leaves of two kinds; but if we consider this *Plant* a little farther, we may observe that it generally grows in standing Pools or Ditches, which about the End of Summer are vacant of Water, and then is left upon dry Ground, where these *Fennel-like Roots* take fast hold, and produce *Plants* for the next Year. We may also take notice that they are *Amphibious*, living as well upon the Land as in the Waters, which is common likewise to the *Mints* and some others. And it may be remark'd, that the *Roots* of this *Ranunculus* are perfectly form'd before the Water leaves 'em to shift for themselves to get their Living in a new Element, and are till that time in a manner suckled by the Mother *Plant*.

A *Shrub* is that Genus of *Plants*, which in every Circumstance, but in its Bigness and Duration, imitates a *Tree*; it has Branches of a Woody Substance, and is *Perennial*: Of this Race are *Gooseberries*, *Myrtles*, *Furze* or *Gorse*, *Mesereon*, *Rosemary*, *Lavender*, *Thyme*, &c. tho' some who are over-nice in their Distinctions esteem the latter as *Under-skrubs*: The *Shrubs* however, without that Distinction, may be reckon'd of four sorts, viz. such as are compleat *Bushes*, and are able to support themselves without Props, as the several kinds of *Roses*, *Althea Frutex*, *Gooseberry*, *Caper*, &c. which last is so rare in *England*, that I

cannot help taking notice of it in a particular manner, having my self brought it to Perfection in *England* without the trouble of Hot-beds or Green-houses; and I believe was the first that has made the *Caper* familiar to our Climate. 'Tis now about four Years since my Friend Mr. *Balle* of *Camden-House* receiv'd some *Caper* Seeds from *Italy*, which I then sow'd in the Scaffold Holes of his Garden-Walls, to imitate as near as possible the Method of their Growth about *Toulonne*, and at the same time put several of the *Seeds* into a Hot-bed; the Consequence was that those which were sown in the Wall-Rubbish shot near six Inches the same Summer, and the few that came up in the Hot-bed were scarce three Inches high the first Year, altho' they were hous'd with the tenderest Exotick *Plants*, and those in the Walls stood the Winter without Shelter. The second Year those *Plants* in the Walls made Shoots of a Foot in length, while those in the Pots hardly added two Inches to their height. The third Year in *April* I cut the Shoots of the foregoing Summer from the *Plants* that were abroad, leaving only a Bud or two of each near the original *Stem*, which the same Summer made Shoots near three Foot long, to the number of about Forty upon each *Plant*, and put out Buds for Blossoms, but the *Plants* in the Pots did not advance above two Inches. In short, the last Year one single *Plant* in the Wall had not less than a quart of Blossom-Buds upon it fit to pickle, and the *Plant* perfected some of its Fruit. Thus if the *Plant* be headed down in the Spring like a *Willow*, it will every Summer make a beautiful *Bush*, and afford us as good *Capers* as grow in *Italy*.

The second Race of *Shrubs* are such as have a natural Tendency to twining or twisting their Shoots about Props, as the *Hony-suckles* or *Wood-binds*, and *Jessamines*, &c.

The third sort have *Claspers*, which take hold of every neighbouring Twig or Stake to support their rambling Branches, and thereby are defended from the Injuries they might receive by
high

high Winds and Storms: Of this kind is the *Vine*, and the *Maracoc* or *Passion-Tree*.

The fourth kind of *Shrub* is that sort which Nature has furnish'd with such Tendrils (for Climbing) as strike their Points into the *Bark* of *Trees*, and which I suppose help to nourish the *Plants* they proceed from, as well as to assist them in their Climbing; and I rather believe they draw some Support from the Juices of the *Trees* they strike into, because the *Trees* they grow about seldom or never make such vigorous Shoots as others that are clear of them: Of this kind is the *Ivy*, and *Virginia Creeper*, with some others.

A *Tree* is that sort of *Plant*, which of all others is the most lofty in its Growth, and has its Parts more robust, firm and lasting than any kind of *Plant* yet mention'd; and to these its Perfections we may add, that it enjoys a longer Share of Life than any other *Vegetable*; and those chiefly among *Trees* are of the longest Last which are of the slowest Growth.

Among *Trees* we may make the following Distinctions.

First, The *Pomiferous*, or *Apple-bearing*, as the *Apple*, *Orange*, &c. which have their *Seeds* in *Pippins*, or *Kernels*, in the Center of their *Fruit*.

Secondly, The *Pruniferous*, or *Plumb-bearing*, as *Plumbs*, *Apricocks*, *Peaches*, &c. which are call'd *Stone Fruit*, and carry but a single *Seed*, cover'd with a thick hard Shell in each *Fruit*.

Thirdly, The *Nuciferous*, or *Nut-bearing Trees*, as the *Walnut*, &c. which differ from the foregoing, in bearing *Katkins* and *Female Blossoms* at Distances one from another upon the same *Trees*; they bear one single *Seed* or *Nut* in each *Fruit*, which, like the former, is cover'd with a hard Shell, and upon that has commonly a Coat of a fleshy Substance.

The Fourth kind of *Tree* is *Coniferous*, or *Cone-bearing*, as the *Fir*, the *Pine*, the *Cedar* of *Libanon*, &c. whose *Cones* are of

of a hard woody Substance, containing a single *Seed* under each of their *Squamme*.

The last I shall take notice of are those which are *Glandiferous* and *Mast-bearing*, such as the *Oak*, *Beech*, *Ash*, &c. which all have their *Seeds* enclosed in single Shells, without *Flesh* or *Pulp* upon them.

We may remark in the next place, that a *Tree* is a *Body* on which is dependant many *Kinds* of *Vegetable Bodies*; the first are those which cannot subsist without it, or get *Nourishment* sufficient to maintain themselves elsewhere. The second are such as may be taken from it, and made so familiar with the *Juices* of the *Earth*, that they strike *Root* and *Vegetate*, till they become as perfect *Plants* as the *Originals* they were taken from.

The first *Vegetative Bodies* or *Plantulae*, which more immediately relate to the *Tree*, are the *Stamina* with their *Apices*, found in the *Blossoms*; these are for the most part like so many *Fungi* taking *Root* in the *Foot-stalk* of the *Flower*, or else in the *Bottom* of the *Calyx*: Their *Office* is to impregnate the *Stiles* of the *Blossoms* with the *Farina* they produce; and as soon as they have done that *Work* they fade and drop off. We may see one of these *Stamina* with its *Apex* and *Root* done by the *Microscope*, at the End of my third Part of *New Improvements of Planting*, &c.

The *Petals* or *Flower Leaves* are also *Plantulas*, almost of the same kind; their *Office*, as we have already observ'd, is to guard the tender *Organs* of *Generation* from *Cold* and other external *Injuries*; these also having perform'd their *Work* drop from their *Mother Plant*: The longest of their *Life* (as well as that of the *Stamen*) is two *Months*.

In the next place we come to consider the *Viscum* or *Mistletoe*, which is always a *Super-plant*, and can never be made familiar enough with the *Earth* to take *Root*, or grow in it; and can only be propagated, by sticking the *Seeds* upon the *Barks* of
Trees,

Trees, into which it strikes its *Roots*, and supplies it self with Nourishment from their *Sap*: The manner of its making its first *Roots* from the *Seed*, is, by sending out from its Center three *Claws*, which fix themselves on the *Bark* of the *Tree* in the three Points of a Triangle, and are at their Extremities like the Mouths of *Leeches*, when they are disposed for drawing in their Nourishment; these fasten themselves to the *Bark* of the *Tree*, and begin to separate at the Center of the *Seed*, as if each *Claw* was to become a distant *Plant*; but a Year or two makes us know the contrary; the three *Claws* are then swoln or enlarged enough to meet at their Root-points, and are so strongly united together, that they make the Foundation but of one *Plant*; and the place of their first joining in the Center of the *Seed* opens, and divides, so that there appears three distinct Branches spreading from the *Root*; after this it proceeds to blossom, and bear Fruit, and will live to a great Age. It is remarkable that there is but one sort of *Mistletoe* in *England*, notwithstanding that which grows upon the *Oak* has been the most admired; and I don't find but that the *Mistletoe* of *Apple-trees*, or any others, have the same Parts with that of the *Oak*, and have also the same Vertue; for the *Plants* which the *Mistletoes* grow upon serve only to them, as the Earth does to any *Herb* that is planted in it, that is, to furnish it with a convenient Supply of Nourishment. And I have not yet observ'd that the Physicians have made any Distinction between particular *Plants* growing upon *Sand*, *Clay*, *Gravel*, or *Chalk*, &c. because, as I suppose, they think a *Plant* still preserves its original Vertue, let it grow in any Soil; but this will admit of many Disputes: We know that half a dozen *Grafts* or *Cions* of the *Golden Pippin* may be engrafted upon as many different sorts of *Trees*, and yet the Properties of the *Golden Pippin* still preserve themselves in all the *Grafts*, tho' they have different kinds of Nourishment from their several Stocks; but an *Oak* planted upon a dry Hill will not shoot

shoot a third part so much as another of the same kind will do in Clay or a moist Bottom; and the Difference of the Graft of their Wood, or Size of their Vessels, are in proportion to the Growth of those *Trees*; from whence we may judge that the Juices filter'd through the small *Tubes* of one *Tree*; must be twice as fine as the Juices passing through the large *Tubes* of the other; and then a *Cube* of an Inch taken out of the Solid in the small *Tree*, must contain a different proportion of Vertue, from a *Cube* of the same Dimensions taken out of the larger *Tree*; but this Case I shall treat of more at large in some other place:

But I cannot leave the *Mistletoe* without taking notice of two Things: In the first place, as to its Method of Growth, the ingenious Dr. *Douglas*, F. R. S. has made several Capital Discoveries, which he has communicated to the Royal Society, and is yet so observant in the Progress of that *Plant*, that we expect he will oblige us with further Observations. On the other hand, (after it has been consider'd botanically) I have the Happiness to say my worthy Friend Sir *John Colebatch* has given us a generous Account of its Vertues, and, with the true Spirit of a *Briton*, has put the Key of Life (as I may call it) in the Hands of those who are troubled with the worst Distempers, I mean Epileptick Cases, which sometimes lead Men to that Extravagance, that in former Ages they have been esteem'd as mad Men, People bewitch'd, or possess'd with Devils. And these deplorable Circumstances of Mankind may have given Occasion to two Things which are very remarkable; First, That when the *Druids* lived they had the Knowledge of Diseases that were incident to Human Bodies, and had the Knowledge of the *Mistletoe* in this case, by which they might probably appear as Demi-gods in the Eyes of the People. Secondly, That the *Oak*, which was held as sacred by them, was chiefly the *Tree* that the *Mistletoe* grew upon; not to mention the other good Qualities of the *Oak*; and from hence it may
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be likewise, that by Tradition the *Mistletoe* of the *Oak* is now in Esteem beyond the rest.

We are next to consider such *Mosses* as are found growing upon the *Barks of Trees*, and chiefly upon such as are distemper'd and declining in their Vigour; for it can hardly be said that a healthful *Tree* ever produces any *Moss*. The *Mosses* which are the greatest Sign of ill Health in *Trees*, are the *Cup Moss*, and some others which branch like *Corel Lines*, and a third sort resembling a *Bunch of Wool*: These are all white, and bear *Seeds*, but are not in other respects so perfect as the *Green Mosses*. The Time of their Shooting is in *October*, when the Rains begin to fall.

We come now to treat of such *Vegetable Bodies* as are depending upon *Trees*; but may nevertheless be made so familiar with the Juices of the Earth, that from a single part of a *Tree* they become *perfect Plants*. The first of these are the *Leaves*, which contain in themselves such *Vegetable Principles*, as give them a Power of producing as *perfect Plants* as the Originals they were taken from. For instance, Plant the *Leaves* of *Orange Trees*, or other Ever-greens, in fresh Earth, they will strike Root, and produce *perfect Plants*, if they are well water'd and kept in the Shade, as my self and Mr. *Thomas Fairchild* of *Hogsdon*, with some others, have experienc'd; so that the *Leaves*, besides their Use in helping the *Buds* to germinate while they are growing upon the *Trees*, may be then esteemed perfect *Vegetable Bodies*. The *Leaves* of *Aloes* being set in like manner will produce *perfect Plants*; and even the *Fruit* of the *Opuntia* or *Indian Fig*, when it is full grown, being set into the Earth, will strike Root and become a *Plant* as *perfect* as the *Mother* it was taken from: By this Method I have often saved several *Plants*.

The *Twigs* and *Branches* of *Trees* are really so many *Plants* growing upon one another; for as they all proceed from *Buds*, or may rather be said to be *Buds* explained, we may thence infer that the *Buds* they came from did in every respect perform the

Office of a *Seed*: The *Twigs* take Root in the *Branches*, and the *Branches* take Root in the *Stem*.

It is to be observed, that all these, taken separately, may be made by some means or other to take Root; and even the very *Roots* themselves of a *Tree*, being cut to pieces, and planted after a proper Method, will vegetate and become perfect *Trees*. Dr. *Agricola* of *Ratisbone*, in his *Philosophical Treatise of Agriculture*, prescribes several Methods for raising *Trees* from their different Parts, by the Assistance of *Vegetative Mummy*, as he calls it; and I have already tried some of his Experiments, which answer beyond Expectation; the Account of which may be seen in my Preface to the *English Translation* of his Book. He has four or five several sorts of *Vegetable Wax* or *Mummy*, that he makes use of for propagating all sorts of *Trees*: His Method is to dip both Ends of his Cuttings, whether of *Roots* or *Branches*, in one or other of these Preparations, and by that Means the Juices contain'd in each Cutting are preserv'd and nourish'd till they are dispos'd for striking Root, and then the *Mummy* cracks and gives way to the tender *Fibres*. I am of Opinion, was this Way to be further consider'd, and some Improvements added to that Gentleman's Method, we should not only be sure of making the Cuttings of every kind of *Plant* strike Root, but forward them extremely in their Growth: as for Example: Was I to raise *Peach Trees* from Cuttings, I would get together a large Parcel of young Shoots of *Peach Trees*, about Mid-summer, and press the Juice from them, which I would afterwards put in a Dunghill, or some other Heat equal to it, to digest for three Weeks or a Month; I would likewise burn a large Parcel of *Peach Tree Branches*, and lay by their Ashes for three or four Months, or more, till they became almost like Earth it self; of these two Ingredients I would make a Paste to enclose the bottom part of my *Peach* Cuttings, sealing the Top of each Cutting first with common Pitch, or some such like Matter, and then set them in the
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the Ground, and keep them well watered; I suppose, if Cuttings, ordered after this manner, strike Root, they cannot fail of a vigorous Growth, as the Paste they are enclosed in contains every thing agreeable to the Nature of the *Plant* it encloses; and so the Cuttings of every sort of *Tree* may be order'd after the same manner.

Could we by this, or Dr. *Agricola's* way, be certain of the Growth of the Cuttings we plant, we should be sure of having such a Collection of *Fruit* as we most desire; for the *Branches* or *Twigs* may be cut when the *Fruit* is ripe upon the *Trees*. This leads me to consider the Use of *Soap*, which I was inform'd some time ago has an extraordinary Effect on the Vegetation of *Trees*, by anointing the *Roots* with it.

I was told by a curious Lover of *Plants*, that last Year, in *June*, he transplanted a *Bay-tree* of an Inch diameter in the *Stem*; but for the more convenient Carriage of it from place to place, he cut down the *Plant*, and left only six Inches of the *Stem* remaining; and at the same time cleared the Earth from the *Roots*, and anointed them well with common *Soap*; in this State he planted it in a Pot, and watered it every Morning; the Consequence was, as he says, that the *August* following it had shot out three *Branches*, each about two Foot long, out of the hard Wood of the *Stem*. This Vegetation seem'd so extraordinary to me, that I could not help immediately enquiring into the Nature of *Soap*, and the Ingredients of its Composition, which I found to be *Ashes* of *Vegetables*, *Oils* of *Vegetables* or *Fish*, or *Tallow* of other *Animals*; I concluded then that the *Ashes* and the *Oils* of *Plants* might reasonably contribute to Vegetation; and the common Custom of manuring Lands in the Western and other Parts of *England* with *Fish* of several kinds, made me judge that their *Oil* must contribute to the Growth of *Plants*; and the common Method of laying dead *Animals* to the *Roots* of decaying *Trees*, to invigorate them and restore their Health,

gave me good Reason to approve of the Use of *Soap*, which I have this Year anointed some Cuttings with, especially of *Vines*, in *July* last, which have hitherto preserved their *Leaves* fresh and green, and are now (in *August*) beginning to shoot.

But besides the Help which *Soap* may give to the Vegetation of *Plants*, I am apt to believe it will be of great Use in the Removal of *Plants* to any great Distance; for what chiefly gives the Check to a *Plant* in its Removal, is, that the Air shrinks and dries up the Vessels and *Parenchymous* Parts of the *Root*, so that they are not for a long while in a Condition to draw in their *Sap* freely; but I conceive that *Soap* will help this Case, if the *Roots* are well anointed with it when they are fresh taken out of the Ground, especially in such *Plants* as are Tap-rooted; and it will be further of use in keeping the Air from the *Roots* after the *Plant* is set in the Ground, till the Earth is firmly settled about them. But as I have yet made but few Experiments in this way, I shall leave it to my curious Reader to try some ordinary *Plants* with it, before he runs the Hazard of a large Quantity; for whether it will agree alike with all sorts of *Plants*, I cannot yet determine.

As we have already taken notice of the most remarkable Particulars relating to *Plants*, we come now to say something of their Degrees of Growth, and their Progression in Weight and Stature, from the Time they were enclosed in the *Seed*, to the Fullness of their Perfection. In order to this I shall begin with the Weight of an *Acorn*, and compare it with a full grown *Oak*, which it may produce; I suppose about twelve *Acorns*, fresh from the *Trees*, weigh an Ounce, and an *Oak-tree* in its most perfect State, (which is I suppose at a hundred Years Growth) with its *Roots* and *Branches*, may probably weigh about fifteen Ton; so that in a hundred Years a single *Acorn* weighing one twelfth of an Ounce, has increas'd its Weight 33600 Pound, which is 537600 Ounces, or an Increase of Parts of equal Value with its
first

first Weight 6451200; so that one Year with another, for the Term of an hundred Years, it gain'd 64512 Parts, which is 5376 Ounces; for it would be ridiculous to imagine, as some have done, that an *Acorn* that had shot vigorously the first Year, so as to be perhaps six or eight Inches high, should weigh as much as a Year's Growth when the *Tree* is fifty Years old; or that every Year, during the whole time of its Growth, it gains equal Sums of Weight: no; the Case is quite otherwise, as we find by Experience: the first Year the young *Oak* weighs about three times as much as the *Acorn*, and the second Year about three times as much as the *Tree* of one Year, and the third Year three times as much as the second, and so on in that Mathematical Progression, during the chiefest Time of its Growth; not to reckon the Weight or Number of the *Acorns*, which it might reasonably bear, from about its thirtieth Year to the hundredth Year of its Age, which I conceive cannot be less than a hundred Bushels, which may probably contain in Number 384000 *Acorns*; (for reckoning sixty Glands to the Pint, which is 3840 to the Bushel, in a hundred Bushels there will be the aforesaid Number;) and if we suppose them to weigh after the rate of twelve to the Ounce, the whole amount of Weight will be 32000 Ounces, or 2000 Pound: But I have been as moderate in this Computation of the *Acorns*, as I have been before in the Weight of the whole Body of the *Tree*, with its *Roots* and *Branched*, which I have only reckon'd fifteen Ton. I once remember four Sacks of *Acorns* were gather'd from one *Tree*, which amounted to sixteen Bushels; and I believe then one may reckon five Bushels to be the Produce of a good *Tree*, one Year with another, which, for the Space of a hundred Years, amount to five hundred Bushels, weighing (according to the foregoing Account) ten thousand Pound, and are in Number 1920000; so that if we allow the Weight of the *Leaves* and *Husks* of the *Acorns*, which the same *Tree* produced in a hundred Years, to be equal to

to the Weight of the *Glands*, then that *Tree* has drawn Nourishment from the Earth, Water, and Air, in that Period of Time, 524000 Pound Weight, which is a wonderful Increase.

In *Annual Plants*, such as the *Cucurbit* or *Gourd* kind, the proportion of Weight in the full grown *Plant* compared with the Weight of the *Seed*, is much the same with that in the *Oak*; and the progressive Growth of the *Plant* I suppose to be much like that of the *Oak*, in proportion to the Length of its Life. In the *Gourd* kind we may reckon a *Seed* to weigh about a thirty-second part of an Ounce, which *Seed* coming to explain it self into a *Plant* of full Perfection, will spread its *Vine* in six Months to such a prodigious Length, that I have measured from the extream Point of one *Branch* to the Extremity of another above thirty Foot, at which time there were growing on it five large *Fruit*, weighing about twenty Pound a-piece one with the other, and as many small ones as might probably weigh thirty Pound; the *Leaves*, *Stalks*, and *Roots*, I suppose, weigh'd about forty Pound; so that the whole had gain'd in six Months near an hundred and seventy Pound Weight, which is 87039 thirty-second parts of an Ounce more than the Weight of the *Seed*. The *Fruit* of the largest kind of *Gourd* is of an Egg-like Figure, sometimes two Foot in length, and the Diameter of its Breadth a Foot; and this vast Fruit is not longer than forty Days coming to its full Growth; now supposing it but twenty Inches long, and ten Inches thick, it then grows half an Inch in length, and a quarter of an Inch in breadth, one Day with another.

The *Leaves* of the same *Plant*, when they are full grown, measure about ten Inches over; these, from their State in the *Bud*, till they are fully explain'd, require about seven Days; so that in the Progress of their Growth they are expanded about an Inch and half one Day with another. Now when *Vegetables* grow with this sudden Encrease, I see no reason why we may not observe their Motion with a good *Microscope*; for every one
knows

knows (who has been conversant with *Microscopes*) that we have some Glasses which will magnify a simple Point, such as is not bigger than a Grain of Sand, so as to make it three Inches over, or shew a Diameter of as much; then supposing an Inch and half is the Produce of twenty four Hours, and allowing that an Inch in length is equal to fifty Points, then in twenty four Hours the *Leaf* grows seventy five of these Points; and if we allow every one of those Points to measure three Inches by the *Microscope*, the Produce of a Night and Day is eighteen Foot nine Inches; so that if we were to fix a *Microscope* over one of these *Leaves*, when the Sun shines upon it, I do not doubt but we might observe the Circulation of the *Sap* in the *Leaf*, and have the Satisfaction of seeing the *Plant* grow, and its Parts move, much quicker than the Minute Hand of a Clock, and without Pauses or Rests in its Motion.

As the Growth of *Plants* is thus easy to be discerned, and the Circulation of their Juices and the Mode of their Generating is now pretty generally received; some unskilful People have also thought that some of them had a Share of Sensation, as the *humble* and *sensitive Plants*, the *Wild* or *Spurting Cucumber*, the *Seed-Pods* of *Female Balsoms*, with others of the like Nature; but this is far from Reason, when we consider that the Fruit of the *Wild Cucumber* never flies from its *Vine* till its Vessels are over-repleat with Juices, which is the same case with the *Seed-Pods* of *Balsoms*, whose Parts are so full when they are quite ripe, that the *Pod* bursts open upon the least Touch; but the falling down of the *Leaves* of the *humble Plant*, and the closing of those of the *sensitive*, seems either to proceed from the Tenderness of the Vessels, which convey their *Sap* into them, and fasten them to the *Twigs* they grow upon, or else that they cannot bear any Cold or uncommon Motion of the Air. For in a warm Day, when the Air is serene, these *Plants*, if they stand abroad, are not affected by it, or will scarcely give way, tho' they

they are touch'd with some Violence; but if the Weather be cool they are seemingly declining, and resist the Touch without any Alteration. On the contrary, when they are kept continually under Glasses, and the Sun shines upon 'em, they do not only decline if they are touch'd with the Hand, but are subject to the same Alteration by any extraordinary Pressure or Motion of the Air made by a Fan or Handkerchief at some distance from them; and I observe that they never appear in a right State of Health, or have their Leaves expanded, from the time of the Sun setting till it is risen.

Thus I think I have remark'd what is most necessary to be observ'd in *Plants*, and may be sufficient to give us an Idea of their Share of Life and Growth; they have *perfect Form* every one according to its Tribe, and may be as easily distinguish'd from one another, as the various Bodies observable in the *Animal Kingdom*.

Explanation of the Figures relating to this Chapter.

P L A T E I.

Fig. III. *The Echinomelocactus, or Melon Thistle, growing in Nevis, St. Christophers, and others of the Caribbee Islands, commonly call'd in those Parts Turks-head or Popes-head.*

Fig. IV. *The Upright Torch Thistle, growing wild in Jamaica, and other Parts in the West Indies, near the same Latitude.*

Fig. V. *The Opuntia or Indian Fig-tree, growing in Carolina, and about Florida.*

Fig. VI. *A Shoot of the foregoing Plant shewing its Leaves.*

Fig. I

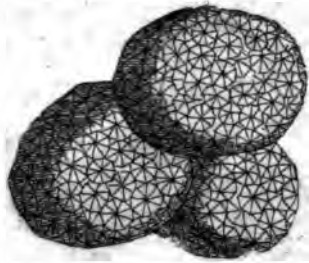


Fig. 2



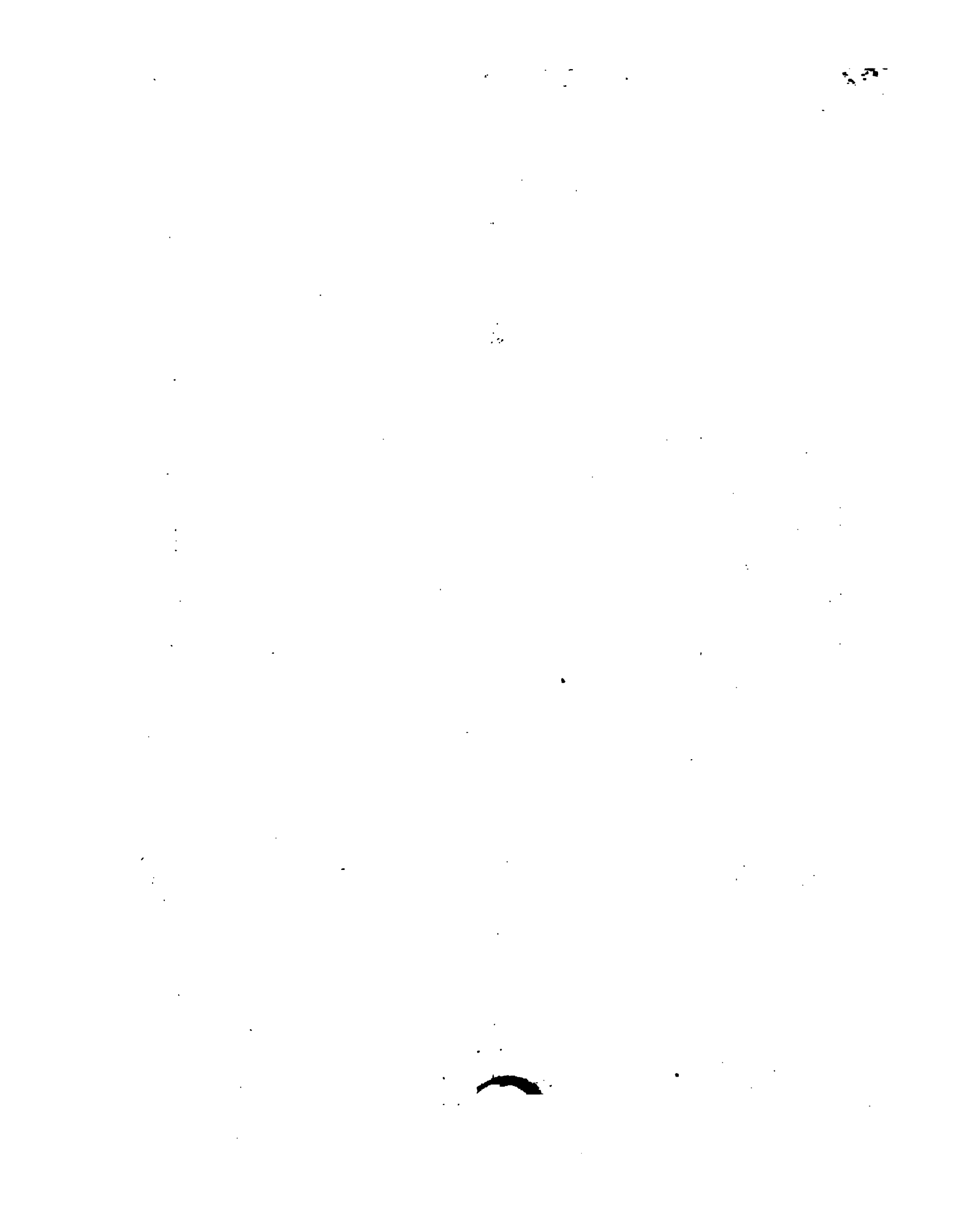
Fig. IV

Fig. III

Fig. V



Fig. VI



C H A P. IV.

Of IMMOVEABLE SHELL-FISH, and of such as have LOCAL MOTION; with Variety of Observations upon the rest of the FISH-KIND in Salt and Fresh Waters.

HAVING taken notice in the former Chapter of such *Plants* as are esteem'd the most *Perfect*, and made mention of the most remarkable Particulars relating to their State of Life and Manner of Growth, I come in the next place to treat of those Bodies, which, like *Plants*, want *Local Motion*, but have such a Share of Animal Life as to afford them the Power of Sensation.

Of these there are the *Oyster*, the *Muscle*, the *Cockle*, the *Barnicle*, &c. which are never capable of removing themselves from their first Station, as far as I can yet learn, notwithstanding we find of them in and about some Shores or Rocks, where they had not been observ'd before; but this happens from the *Spawn* of them, which flits upon the Waters, and is carry'd from place to place by the Winds or Tides.

It is remark'd by some curious Observers of Nature, that such *Shell-Fish* as are *immoveable* are *Androgenous*; that is, each respectively possesses the *Male* and *Female* Parts of Generation, so as to be capable of impregnating it self without the help of another of the same Kind; which is the same case with that which I have mention'd to be natural to *Plants*, which are each of them confin'd to their several Stations, without the Power of seeking at any Distance one of a contrary Sex; for which reason we may judge that the necessary Parts, for propagating of their respective Kinds, were thus disposed by Nature.

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The *Oyster* has its Station under such a Depth of Waters, as seldom or never to be left uncover'd by them; but the *Muscle* has generally its Situation in such Places upon the Shore, or Rocks, as by the Fall of the Tides they become expos'd to the open Air; and commonly are found in Beds of large Extent, sometimes covering near an Acre of Ground, as we may find in several Places on our *English* Coasts: The *Cockle* is always bedded in the Sand upon those Shores that are uncover'd at low Tides, and are seemingly fed like *Earth-Worms*, which draw their Nourishment only from the Earth or Sand which passes through their Bodies; but *Muscles* and the *Oyster* we often find will feed upon Sea-weeds when they can come at them; tho' I am of Opinion that their most ordinary Food is Mud and the Wash of the Sea. About three Miles from *Colchester* there are little Pits near the River which receive the Tides at High-water, in which they place Baskets of *Oysters* newly brought from the Sea, letting them remain about fifteen Days or three Weeks, to purge themselves from their natural Food, and grow green by feeding upon a sort of *Crow-Silk*, which is in great plenty in those Pits, and then they are reckon'd in a right State for Barrelling up for the Markets, and are allow'd to be much better relish'd than any other *Oysters* found in our *British* Seas, tho' there are much larger about *Tenby* and *Milford-Haven*. In some Parts of the *East Indies* there are *Oysters* of that prodigious Size, that a single *Shell* will weigh above an hundred Weight; as we may be farther inform'd by the Reverend Mr. *Pocock*, one of the Chaplains to the Royal Hospital at *Greenwich*, which curious Gentleman has one of them in his Cabinet of Rarities. What we may observe more particularly in this Strain of *Shell-Fish*, is first, that they have no bony Substance within their fleshy Parts; nor do they enjoy the Benefit of Sight, Hearing or Smelling, that I can yet discover; neither indeed do I think the necessary *Organs* for those Senses can reasonably be sought for in such Bodies as have a fix'd State
of

of Life; the Senses of Feeling and Tasting being sufficient for the Maintenance and Support of them. These enjoy a more perfect Share of Life than *Vegetables*, which have only a degree of Life, without any Sense that we can yet find out. Again, as the Bodies of these *Shell-Fish*, of themselves, would perhaps be subject to the voracious Appetites of the *Fish* of Prey, Nature has wisely given them Coverings or Cases of so hard a Substance as to secure them from that Danger; these *Shells* have a kind of Vegetative Growth, and have also Vessels of Communication with the Animal they contain; so that it seems as if the Juices of the one were necessary for the Support of the other; which Case is well worth the Consideration of the Curious, as it is partly the same in the *Folium Ambulans*, or *Walking Leaf*, which I shall treat of at large in the Chapter of *Insects*.

There are yet many other kinds of *Immoveable Animals* of the Waters, which I might have mention'd in this place; but at present, as my Intention is only to offer this as an Introduction to Natural History, I shall content my self with giving but a few Instances of such Things observable in Nature's Works, as may tend to explain to us what Affinity the several created Bodies have one to another, both with regard to their Frame, and their Power of Growth and Motion: And for the better Information of my Reader, shall chiefly draw my Inferences from such Subjects as may be come at with the greatest Ease.

The next I shall take notice of is the *Scallop* and *Pectuncule*; which last have a perpendicular Motion in the Water, raising themselves from the Bottom in a right Line to the Surface, by flapping their *Shells* with a very quick Motion; and I suppose the *Scallop*, which seems only to be a larger kind of them, has likewise the same Mode of Motion, which is worthy our Enquiry.

While I am writing this, I have fortunately met with some very curious Observations of Mr. *Lewenhook's*, relating to *Muscles*,

in the *Philosophical Transactions*, N^o 336, and especially tending to prove them *Androgenous*. That learned Gentleman first observes that *Muscles* lay their Eggs in Strings, regularly placed one by another upon the Out-side of their *Shells*, and that this *Spawn* or *Eggs* continually encrease in Strength till they become perfect *Muscles*, at which time part of their *Egg-shells* is discoverable upon the outward covering of the *Fish*, till that Coat is harden'd or changed into a firm *Shell*.

The next Observation was made *November* 18, upon the *Ovarium*, or *Egg-Nest*: at that Season our Author discover'd some of their *Eggs* were placed on the Outside of the *Shells*, while others were yet lodg'd in the *Ovaries*; these unborn *Muscles* had their sharp Ends fasten'd to the String or Vessels by which they receive their Nourishment. Some Days afterwards he observ'd twenty five other *Muscles* that had not yet placed their *Eggs* upon their *Shells*; from these he took a great Number of *Eggs*, which he examined with the *Microscope*, and found some of them so small, that he could but just observe the Figure of them; from others he took some that were larger, of a brownish Colour, mix'd with little Specks; in these *Eggs* he discover'd some of the Parts of the little *Fish*, but the smaller *Eggs* were transparent. In fine, having examin'd a great Number of *Muscles*, and found the *Ovaria* or *Egg-Nests* in them all, he concludes, that every *Muscle* brings forth young ones, laying them not only upon their own *Shells*, but upon those of others; so that sometimes a *Muscle* is quite cover'd over with *Eggs*. He tells us, that it is his Judgment, after several Observations, that most of the *Shell-Fish* bring forth their Young without the help of *Males*; each particular *Fish* impregnating it self; for that in all those *Muscles* which he had observ'd, he found in the smallest Particles of their Beards, by the help of *Microscopes*, that in each Part (which was not the hundredth part so big as a common Grain of Sand) there was a vast Number of Motions, which remain'd
for

for some time after it was taken off from the Body of the *Muscle*. In these Parts he has several times observed *Animalcules* swimming; and the small Parts that lay round about were put into such a Motion, that he says one may be apt also to take them for *Animalcula*; and this gives me reason to believe that the *Beard* of the *Muscle* may perhaps do the Office of the *Male* Part. But this is only Conjecture, and deserves further to be considered.

As to the Food of *Muscles*, he gives us room to suggest that it is the finest Sandy Parts, and some kind of Sea-weed; for he has been as accurate in the Description of the Stomach, as he has been in his Enquiry after those Parts which are appointed for Generation.

We are in the next place to treat of such *Shell-Fish* as have *Local Motion*, such as *Lobsters*, *Crabs*, *Star-Fish*, &c.

The Habitation of the *Lobster* is in Holes among the Rocks, where the Sea never leaves them; they have a Power of moving forwards with great Nimbleness, either by swimming in the Water by the Assistance of their eight smaller Legs, placed four on each side, or the Flapping of their Tail, or the Finns lodged under it; these *Finns* are edg'd with a kind of Fringe, the better to hold for some time their *Spawn*, which is not much unlike *Cole* or *Cabbage Seed*, but chain'd together. Its Motion at the Bottom of the Sea, or upon the Rocks, is assisted by its larger *Claws*, wherein they have so much Strength as to resist a Force equal to sixty Pound Weight; and by means of *Muscles* in those *Claws* are capable of pinching any thing they can lay hold of with that Strength, that it requires a considerable Force to make them quit their Hold; and, as I am inform'd by some *Lobster* Fishers, will rather lose their *Claw* than part with what they have laid hold of: which brings to my Mind what is related of them in the *Memoirs of the Royal Academy of Paris*, for the Year 1711, where it is reported, that if one of the larger *Claws* is broken off, and the *Lobster* still remains in the Sea, it will
grow

grow again, or be renewed; which is the Reason, perhaps, that we seldom find the large *Claws* of the same *Lobster* both of one Bigness. If this be true, we may suppose that the State of *Lobsters* is partly *Vegetable*, partly *Animal*; for *Vegetables* have a Power of renewing their *Boughs* or *Branches* when they are broken or cut off; but no *Animal* that I know of has the Power of renewing a lost Limb.

To assist them in catching their Prey, they have two Eyes, and two jointed *Antena*, which reach a considerable Length before their Bodies, and in which I suppose there is contained their most subtle Sense of Feeling, even so as to give them notice by the trembling of the Waters of the Approach of their Enemies, which are out of the Reach of their Eye-sight, or perhaps to feel out their Food lying at the Bottom of the Sea, which the Situation of their Eyes cannot allow them to discern. For the better Marceration of their Food before it enters the Stomach, their Mouths are guarded by four or five Pair of toothed Jaws, each of which has a Power of acting by it self.

I have not yet had Opportunity of satisfying my self, whether there are *Male* and *Female Lobsters*, or whether they act in Generation as *Snails* do; that is, if each respective *Lobster*, in the time of Coupling, performs the *Male* and *Female Act* at the same time: for in all the *Lobsters* I have opened in *June* and *July*, I find either the *Spawn* is excluded from the Body, and lodged among the *Fins* under the Tail; or else I have observed a *Spawn-like Body* (which I suppose to be the *Ovaria*) running through the Flesh of the *Lobster*, from a place near the Stomach to the *Orifice* under the *Tail-Fins*. But this Matter I shall treat of more at large, when I have had Opportunity of examining it with more Exactness

The Natural Historians have reckoned near thirty several sorts of *Lobsters*, all of which are cloathed with *Shells*; and by what I can learn, there are not fewer Kinds of *Crabs*, some of them
very

very poisonous: The larger sorts of them are commonly found among the Rocks, and, like *Lobsters*, are never uncovered by the Waters; but the smaller Kinds are often found upon the Shores at Low Water. I do not hitherto find that any of this Race have the Power of Swimming, or have any Parts analogous to *Fins*.

The *Crab* which I shall chiefly take notice of is that sort commonly found upon our *English* Coast: it is like the *Lobster*, with regard to its number of Legs and large Claws, whose Texture and Parts are nearly the same with those of the *Lobsters*; their Body is placed in the Center of their Legs, like that of the *Spider*, but their Motion is Latitudinal or Oblique, contrary to that of the *Lobster*, which is Direct: This Side-Motion of the *Crab*, I suppose, happens for want of that jointed Tail to guide it in its Motion, which serves partly as a Rudder to guide the *Lobster* forward. The Eyes of the *Crab* are more prominent from the Body than those of *Lobsters*, and are so situated, that they can turn them to any Point which they are prompted to move to; for which reason I suppose they are wanting of those *Antennae*, or *Feelers*, which we observe in *Lobsters*; but some remark that their Side-Movement is directed by their right Legs, which they say are always larger than those on the left side. I suppose the manner of their Generation is somewhat like that in *Lobsters*, although they want those *Fins* under the Tail for the Preservation of the *Spawn*. For I have observed in the smaller Kind of *Crab*, which I suppose is in most Respects analogous to the larger sort, that the *Eggs* are preserved in a Knot closely link'd together immediately under the Apron, after they are excluded from the Body of the Mother; and the Time of their Spawning is the same with that of *Lobsters*.

The *Star-Fish* is another Genus of *moveable Shell-Fish*, tho' its Motion is trifling in comparison with the former; and of these there are several Kinds, tho' I have seen but three sorts, viz. the *Stella Marina Major*, the *Stella Marina Minor*, and the

the *Stella Marina Arborefcens*: The Motion of the first two is performed by bending their jointed Rays backwards and forwards; but the latter I suppose must be much quicker, if it can make use of all its Ramifications, which are some thousands in number. The largest of this Kind that I have seen is now in the *Museum* of the Royal Society in *Crane-Court, Fleetstreet*. The Mouths of all this Kind are in the Center of their Bodies; and I do not find any *Orifice* for the Discharge of Excrement, no more than for the Service of Generation. So odd a Creature as this is well worth the Contemplation of such curious Persons as live near the Sea, where every Day they have Subjects enow to employ their Curiosity, and improve their Understanding.

I now come to treat of such other *Shell-Fish* as move from place to place, by means of an undulating Motion of their fleshy Parts out of the *Shell*, after the manner of *Snails*: Of these there are several Kinds, some of which can swim or creep at their Pleasure; and others only creep upon the Sands or Rocks. The *Perwinkles* or *Water-Snails*, whether in the Sea or in the Rivers, have the same Mode of Motion; we may observe them swimming on the Surface of the Waters, with their whole Body and Shell reversed in the Water; so that they seem to take hold of the Air, and to receive that Resistance from it, which common Snails do from the Earth, or other solid Bodies which they creep upon. They have a Power of contracting their Bodies so as to enclose them in their *Shells*, and at their Pleasure to relax their Parts, and explain or expand them to such a degree, as to fill up twice the Space of the *Shell*. The Flesh of these Creatures is *Viscous*, and of a porous Texture, by which means they have a Power of adding continually to the Growth of their *Shells*, or re-instating any broken Part of them; for the *Viscous* Matter contained in their Bodies issues out in great Abundance to any fractured Part of the *Shell*, and soon hardens and joins it self with it. So likewise when the Bodies of these Creatures grow too big for their
Shells,

Shells, a Supply of the same Juice serves to enlarge their Coverings. I suppose their Generation is much the same with that of *Land-Snails*, which see in the Chapter of *Snails*, *Earth-Worms*, &c.

The Chief of this Class is the *Nautilus*, *Purpura*, *Strombus*, *Murex*, *Buccinus*, *Trochus*, *Concha*, &c. the Beauty of whose *Shells*, with the surprising Variety in their Structure, is as remarkable as the Diversity of Feathering in Birds, or the various Colouring and Spotting of their Eggs. The great Extent of several of these *Shells* is surprising, some of them weighing near ten Pounds a-piece, without the *Animals* in them. But whoever would satisfy their Curiosity in these Matters, may have recourse to the excellent Cabinets of Sir *Hans Sloane*, Baronet; the *Museum* of the Royal Society; Mr. *Vincent* at *Harlem*; Dr. *Ruysh* and Mr. *Albertus Seba* at *Amsterdam*; where they may behold with Admiration the Beauties collected by those learned Gentlemen. But that we may learn likewise some Account of the Creatures which inhabit these testaceous Bodies, let me once more recommend the Observance of them to those Gentlemen who have the Pleasure of living near the Sea.

I come now to treat of such *Fish* as are Inhabitants of the Salt and Fresh-Waters, that are framed for swimming only, and are of such a Composure and Texture of Parts, as to breath only an Element as dense as Water; for the Air to those Creatures is too fine and rarified for them to subsist in; such as is the Case of some *Animals*, which are taken up upon high Mountains; for there the Air is so much thinner than the usual Air of their Breath in their natural Station of Life, that it does not contain nourishing Particles enough for their Subsistence; and has the same Effect upon their Bodies as they would find in the Receiver of the Air-Pump, if the more heavy Parts of the Air were drawn out; so likewise the *Animals* of the Land cannot inhabit the Waters without suffocating, no more than the Inhabitants of the Waters can live upon the Land, or in the several Stations of the Air.

As the *Fish* I am now treating of have their Motion and Passage from place to place by swimming only, it would be to tax Nature with an Indiscretion to expect any other Parts about them, but what are necessary for such a Life and Motion. We plainly discover, by many Proofs, that the Water is to them of no more Use than Air is to Mankind. Every *Fish*, according to its respective Tribe, has a Food natural to it, as Land *Animals* have, and without that the Waters are not sufficient to maintain them.

The Food of *Fishes* is either *Plants* or *Herbs* of the Waters, *Insects*, or other *Fish*; 'tis for this Reason that they pass from place to place at certain Seasons in search of their proper Food. I am informed that even *Whales* go in Troops from the most Northern Parts, as far as the Coast of *Guinea*, and other Places near the Line, where the Sea is full of Weed, at a certain Season of the Year, and there Couple as *Animals* do, and then in due time return to their Northern Station. The *Whale* is *Viviparous*, and suckles her Young, which, I am told, never exceed two in number. Some few Years since several hundred young *Whales* were driven on Shore upon the *Irish* Coast; and of late several *Whales* have been taken far South in the Western Ocean, altho' it has been for a long time practised to fish for them only in the North Seas, where they were supposed only to reside.

Mackarel, *Herrings*, and many other Kinds of *Fish*, have their Seasons of coming upon our Coasts, as well to seek their proper Food then in the Chanel, and in our Rivers, as to lay their *Spawn*; and I have not heard that any of these Passing *Fish* have been found in our Seas but at the common Seasons. It is likewise to be observ'd, that the *Fish* of Passage swim always in Shoals, and are as punctual to the Times of their coming and going, as the Temper of the Season will permit; sometimes a strong Wind or cold Weather will keep them back fifteen Days later than their usual time, and, on the contrary, I have known
them

them come into the Chanel and our Rivers a Fortnight sooner than they used to do, when the Weather has been warm, or the Wind set to drive them in: But it is no wonder that their Season of Passage depends so much upon the Temper of the Air, seeing every thing which is proper for their Food is equally depending upon the Weather. The Sea or River-weeds must have a certain Temperature of Air to bring them forward; the *Insects* of the Waters, &c. depend also upon the same Cause for their Hatching; and if our Passage *Fish* are *Fish* of Prey, the *Fish* they prey upon will not run before them, if they cannot meet with necessary Food.

As to the Time of Running or Passing of each particular Kind of *Fish*, it must not be expected that I should at present give an exact Account of them; my Observations have not been sufficient to remark the Seasons when the several sorts of *Fish* come into our Rivers, nor have I had Conversation enough as yet with the Sea to give so ample an Account as I hope to do hereafter.

If we may believe the curious Observers of *Fish*, they have two Modes of Generation; the *Squameous* or *Scaley* Kind of them lay their *Eggs* or *Spawn* in shallow Water, and the *Milt* or *Male* covers it with a prolific Juice as soon as it is excluded from the Body of the *Female*; and when the Waters by means of the Weather become of a certain Temperature, the *Spawn* hatches at once into little *Fish*; which for a certain Season swim and feed together in Shoals, not caring to mingle themselves with the *Spawn* or young *Fry* of others, till they are capable of shifting for themselves. 'Tis remarkable, that the smaller they are they delight in the shallower Waters, and as they gradually encrease in Bigness make towards the Deep.

The *Cetaceous* Kind for the most part are said to couple; and in several Kinds of them we may plainly discover the *Male* and *Female* Parts of Generation. Some of them are *Oviparous*, and others *Viviparous*.

The Number of *Spawn* laid by some *Fish* is almost incredible: The *Roe* of the *Cod-Fish*, for Example, in the Space of a *Cube* of one fourth of an Inch contains two hundred and fifty *Eggs*; and according to that Proportion the whole must contain about a Million. The great Mr. *Lewenhook* tells us, that in the Space of a small Sand of the *Male Seed* of the *Cod-Fish* there are above ten thousand *Animalcula*. Now supposing that every *Egg* or *Spawn* of a single *Cod-Fish* should come to Perfection, and that in five Years time every one of those *Fish* should be capable of producing others, supposing only half of them *Females*, the Encrease of them would then be five hundred thousand Millions; and five Years afterward, by the same Reckoning, there would be an Encrease of about a thousand *Miriads* of *Miriads*; which Encrease, in the Space of ten Years, from one single *Fish*, would give us room to suppose, that in one thousand Years, at that rate, the *Cod* only so propagated would fill up more Space than the whole World contains. But we are not to imagine that this vast Number of *Spawn* or *Eggs* can all of them be prolifick, nor is it without the Hazard of being devoured by other *Fish*, or of being destroyed by other Accidents: If only a fortieth part of that which is laid annually in the Sea comes to good, the Waters would hardly be able to contain its Produce. Nor are the *Fish* of the Rivers and Lakes less prolifick, considering their Proportion. A *Carp* does not spawn less than twenty thousand, and perhaps a *Tench* half as many; and I believe we may lay it down as a general Rule, that the more Enemies a *Fish* has to its self and its Encrease, so Nature has taken Care to provide it with such a Capacity of encreasing or propagating its Species, that there is a due Allowance to make good all Losses that may happen.

It is my Opinion, that most Kinds of *Fish* are partly dictated by Nature to shift their Place about *Spawning* time, as well for the Preservation of their young ones as for the sake of their Food. And it is observable, that the *Passing Fish*, after they have
spawn'd,

spawn'd, find out some other Station, perhaps because they would avoid those *Fish* which would prey upon them, if they were to stay in the same Place.

The Forms and Texture of the Parts in *Fish* are as various as what we find in the *Vegetable* Kingdom: every one is provided with necessary Parts to defend it self against, or to avoid, its Enemies. The *Flying-Fish* has Finns of so great a Length, as to do the Office of Wings in the Air for a certain time, till they become dry, as well as serve them for Conveyance from place to place in the Waters: by this Means they avoid the *Dolphins*, which pursue them to prey upon them. One of these sort I have delineated in Plate VIII, Fig. I, which was drawn from that in the Royal Society. The *Sword-Fish* and *Saw-Fish* I have also taken the Figures of, (from those at Mr. *Salter's* Coffee-house at *Chelsea*) to shew what Weapons Nature has provided them with for their Defence; which makes me suppose that they are not without Enemies that prey upon them, notwithstanding they sometimes measure six Foot in length. And, to set aside the fabulous Account of the *Siren* or *Mermaid*, I have likewise in the same Plate added the Figure of the true *Mermaid-Fish*, as it is now preserv'd in the same Collection of Rarities.

The *Orbis Echinatus*, and *Lantern-Fish*, are also naturally guarded with *Spines* which cover their whole Bodies, so that no kind of *Fish*, be they ever so voracious, dare attempt them. Nor is the *Perch* without its *Spines* in the back Finn, which it can raise up at Pleasure for its Defence when its Enemy draws near.

But it is not only by these natural Arms or Weapons that *Fish* preserve themselves, or their *Spawn*, from the *Fish* of Prey; they have likewise a natural Cunning, which furnishes them with Contrivance to make themselves Nests or Cases of Shelter for themselves and their *Spawn*; an Instance of which I have lately been agreeably furnish'd with by the learned -----*Hall*, Esq;
Serjeant

Serjeant at Arms, who made me a Present of a *Tickleback's* Nest, which he observ'd the Structure of from near the Time of its Beginning, till it was brought to the Perfection it is in the Figure: It is compos'd of little *Fibres* of *Roots*, so placed together, as to leave an hollow *Tube* in the Middle, which I suppose was rather compos'd to lay the *Spawn* in, than for a Lodgment for the *Fish* it self; for the *Tickleback* has a sharp Thorn in its back Finn, which I suppose is sufficient to defend it from *Fish* of Prey; but as they always live in the shallowest Water, so their *Spawn* would be too much expos'd to the *Swallows*, or other Birds, which delight to be near the Waters, was it not to be defended from them by some such like Covering. About the End of *May*, or Beginning of *June*, is the Time when these little Builders are at work, as I am inform'd by the above-mention'd curious Gentleman. And since we have this Instance of the Contrivance of one kind of *Fish* for its Preservation, or the Preservation of its Young against Enemies, we may as reasonably conjecture that other sorts of *Fish* have their respective Methods of building Nests or Shelters for their Security, which is no more than all Birds do, tho' after different Manners. And indeed we do not find any living Creature whatever that has not some Sense or other which guides it to the Study of its Preservation: Even the *Cados-Worms* have each respectively, according to its Tribe, a Mode of making its Case or Lodgment after a particular manner, to defend themselves from the *Fish* which are very voracious of them. One Kind makes its Covering of the Points of *Rushes*, another of small *Shells*, and a third of fallen *Leaves*, which by Means of a *Viscous* Matter they glue and cement together in such a manner that it is hard to separate them. The three Kinds which I here mention, were engraved from the Originals in the curious Cabinet of Mr. *Dandridge* in *Morefields*, where there are many other sorts of them among his numerous Collection of *English Insects*.

Fish

Fish seem to enjoy the Power of *Sensation* as perfectly as any other *Animal*. Their Sight cannot be disputed, and even seems to exceed the Sight of many *Animals* for its Quickness; and I suppose their Tasting and Smelling are not less perfect; for we find most Kinds of *Fish* will take one Bait rather than another, altho' they are composed of several Ingredients, and have no regular Form; which seems to determine that either their Taste or Smelling is more pleasantly affected by one thing than another. But indeed I do not find that the curious Observers of *Fish* are of Opinion that they want any Sense but that of Hearing; and even they do not determine whether that Sense is absolutely wanting or not: But if I may be allow'd to judge from an Experiment I have made upon *Carps* in several Places, I believe it will be allow'd that they enjoy that Sense as well as the rest.

At *Rotterdam*, in a Garden belonging to Mr. *Eden*, a very curious Gentleman, I had the Pleasure of seeing some *Carps* fed, which he kept in a Mote of a considerable Extent; the Occasion of my seeing these Creatures, was chiefly to satisfy me that they were capable of hearing. The Gentleman having fill'd his Pocket with *Spinach Seed*; conducted me to the Side of the Mote, where we stood mute for some time, the better to convince me that the *Fish* would not come to us till he call'd them. At length being desirous to see the Event, he call'd in his usual way, and immediately the *Fish* gather'd together from all Parts of the Mote in such Numbers, that there was hardly room for them to lie by one another, and then he flung some *Spinach Seed* among them, which they devour'd very greedily. This alone would have satisfied me that *Fish* had the Sense of Hearing; but upon relating the Story to some curious Gentlemen, I was told, that at Sir *William Bowyer's*, near *Uxbridge*, there is a Pond of *Pikes* or *Jacks*, which they call together at Pleasure, and I think is more surprising than what I have mention'd of the *Carps*; for the *Pike*

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is held to be a more wild, untameable *Fish* than the *Carp*; and as it is a *Fish* of Prey, it has been thought impossible to civilize it, or make it any way familiar with Mankind. There are indeed many Instances of *Carps*, and *Tench*, which will come of their own accord, at certain times, to some particular part of a Pond to be fed; but I suppose they have been trained up from their first Year to feed at one Corner of the Pond rather than another; that is, when one part of a Pond has been continually supplied with such Ingredients as are proper Food for them, either by means of an accidental Drain, or designedly.

I have this Year taken a large Parcel of young *Fish*, just after hatching from the *Spawn*, and have kept them near three Months in Earthen Pans, with a little Earth at the Bottom; the *Fish* are of several Kinds, and do not only thrive, but are now so familiar, that upon my Approach they come in Shoals to the side of the Pans to be fed: The first thing I fed them with was Wheat Flower scatter'd here and there upon the Water, for the *Fish* were then so small that they could not swallow any thing larger than a Grain of Flower; at the same time I gave them fresh Water from the *Thames*, which I suppose was not without some nourishing Parts in it; but now they are large enough to feed upon small *Insects*, and little Bits of Paste made of Flower and Water, which they readily catch at as soon as I fling it in. Towards the Winter I design to enlarge their Bounds, and I suppose then, with a little Care, I may keep them to their familiar way of Feeding, where and when I please: For I find it is with *Fish*, as it is with *Birds* or other *Animals*, that the best way to civilize them, is to have the Management of them when they are very young, and by that Means they may be brought to do any thing within the Bounds of their Comprehension, or that is agreeable to the Structure of their Parts; and their Memory is so constant, that after this early Impression they hardly ever forget it. But the Docility of *Fish*, I believe, does not exceed what I have here related. T.

To consider the Parts of *Fish* more particularly, we may observe that every Kind of *Fish* has its Jaws framed for the taking and macerating of its particular sort of Food: Such as feed upon *Weeds* and *Insects* have seldom any Teeth; but such as prey upon other *Fish* have one, two, or more Rows of Teeth, for the better grinding their Food. The Gills of the *Cod-Fish* are guarded with Tooth-like Bones, which I suppose are no less contributing to Maceration than Teeth themselves. The *Fins* are in proportion to the Bodies of the *Fish* they relate to, and serve as Oars to row them from place to place, and raise them to any height, or sink them to any depth in the Waters, while the finny part of the Tail serves them as a Rudder to guide their Course. And for the more easy bending of their Bodies, their Back-bone consists of very short *Vertebrae*, so join'd together, that their Tail may be easily bent up to the Head; and that such bending of their Bodies may meet with no Obstruction from their outward Coat, the *Scales* are so regularly placed in Rows one over another, and cover'd with such a *viscous* Matter, that they give way without difficulty to the Motion of the *Fish's* Body, and slide with Facility through the Waters.

The *Scales* of *Fishes* are as remarkably different, as the *Fishes* are various which have them for their Covering; and many of them, being examin'd with *Microscopes*, are of very surprising Figures, some of them not unlike the *Shells* of *Pectunculae*. All *Fish* indeed have not *Scales*, but such *Skins* as are of a Leather-like Substance, and *viscous* on the Outside; and I think this last Kind are most of them, if not all, *Viviparous*, bringing forth their Young perfectly form'd. I am assured by many Fishermen, that they frequently take at the *Buoy of the Nore*, about *Christmas*, a *Fish* which they call a *Coney-Fish*, somewhat like an *Eel*; and that at that Season they are full of young ones, alive, and very nimble in their Motion; and I am of Opinion, at that Season of the Year, which is the time when *Eels* bed, or

lay themselves up in the Mud, we might discover the manner of their Breeding.

The Share of Life which some *Fish* possess is very remarkable, and is somewhat like that we observe in some *Insects*: The *Eel*, for Example, being cut to pieces, maintains Life and Motion for several Hours, as if every *Muscle* of its Body enjoy'd a distinct Soul or Spring of Motion whereby it lives, till the Part wanting a Supply of Nourishment is forced to submit. And this is nearly the same in *Plants*, which have in every distinct Part of them (abstracted from the Body) a Power of vegetating and producing every particular Part which may be found in a full grown *Plant* of the same Kind they were taken from. A *Carp* is likewise possess'd of a very subtle kind of Life, and will move vigorously several Hours after the Intestines are taken out of its Body; and I have even seen one of its Finns move a considerable time after it has been over the Fire in a Stew-Pan; but I have not observ'd whether the Heart will beat after it is taken out of the Body, as that of an *Eel* will do, with regular Motion for above an Hour. I suppose that *Fish* are generally long-liv'd, and that *Carps* especially will live above a hundred Years: For in some large Pools or Fleets (as they call them) which have not been fish'd or look'd after in the Memory of Man, there have been *Carp* taken near three Foot in length; and it is very rare to find a dead *Fish* in any Pond, unless it has been kill'd by some Wound or other Accident.

Next to an *Eel* I believe a *Carp* will live the longest of any *Fish* without Water; for it is common to transport them alive in Paniers with Wheat-Straw forty or fifty Miles; and I once had some *Carp* that lived near thirty Hours without Water. I cannot help observing in this place what I have often heard of the *Herring*, that it dies as soon as it is taken out of the Sea, because I can affirm the contrary from my own Knowledge. About two Years since, being in Company with my worthy Friend Mr. *Tho. Balle*, and some other Gentlemen of *Devonshire*, at the
Drawing

Drawing of a Sein or Net, among other *Sea Fish* we caught a large *Herring*, which lived in my Pocket near half an Hour; this gave me a Thought of contriving a Method of preserving some of the smaller Kinds of *Sea Fish* alive, which would be very agreeable to the Sight, and as pleasant to the Palate, if we were to dress them fresh taken out of the Water, when we could have no immediate Opportunity of getting them new out of the Sea.

Where we are near enough to the Sea, and upon a Level with it, we might make little Store-Ponds to be fed by the Tides, which would serve to maintain some Kinds of *Sea Fish*, especially if the Water in those Ponds was always kept in Motion; for we find by Experience the Motion of the Water is as material as the Saltness of it to preserve Life in *Fish* of the Salt Water Race. Witness the Method the Fish-Women in *Holland* take to keep *Plaice* and some other *Fish* alive in Tubs, by moving the Water continually with Paddles, till all their *Fish* is disposed of; for if they were to let the Water stand quiet for a few Minutes the *Fish* would die: Therefore to keep the Water continually moving in the Salt Ponds which I here propose, we might place a couple of Wheels with Trenchers, like those in common Water-Mills, to be turn'd by the Flux and Reflux of the Waters, and by their Motion produce a continued Agitation in the Water of the Ponds; or else where we can have the Benefit of a River to turn a Wheel continually, we might make a Bason to hold a small Quantity of Water, which may be salted agreeable to Sea Water, by adding to it one fortieth part of common Salt, *i. e.* a Pint or Pound of Salt to thirty nine Pints or Pounds of Water. Sir *Hans Sloane* kept a *Turtle* or *Sea Tortoise* a long time in Water prepared after the same manner.

But to return to my Remarks upon the Degree of Life in *Fish*, we may observe that the *Flounder* and many others will live a long time after their Bowels and more noble Parts are taken out

of their Bodies, which is more than we can observe in any of the *Land Animals* or *Birds*; for in them, as soon as the Heart is taken from its original Station, a Struggle or two finishes their Life; which shews plainly that Circulation of Juices in different Creatures is not always promoted by the same Cause, or perform'd in the same Manner. For no Creature can live any longer than their Juices circulate; and every one allows, that in *Land Animals* the Heart is the immediate Cause of Circulation.

It may perhaps be expected that I should be more particular in this Account of *Fish*, and that I should describe the several Kinds of them; but that is not my Design in this Work; my Business at present is to give only a general Account of those Remarkables in the Creation, which I know my self to be fact, and here and there drop such Hints as may lead the Curious to farther Observations, in order for them to frame right Ideas of the Degrees of Life and Motion in the several Particulars of the Creation. We may indeed observe that there are *Whales* of twenty one Foot long, and *Fish* of all Proportions from that Length to an Inch only: and that in some Lakes there are Kinds of *Fish* which are not perhaps found elsewhere: That the enormous Bulk of the *Whale* exceeds all other Creatures upon Earth; and the Smallness of the *Tickleback* is inferior to any Kind of *Bird* or *Quadrupede* yet discover'd. But was I to relate every thing I have heard concerning *Fish*, or other living Creatures, I might swell this to a large Volume, and make my self accountable to the World for a thousand Falsties. Indeed what Informations I have from some particular Gentlemen, who give me leave to back their Relations with their Names, I gladly receive, and publish to the World as so many Instances of their generous Spirits and Curiosity. I confess that I have not read much upon this Head, but avoided those Books which treat of the Subject of this Work, as much as possible, lest I should be too much bias'd by
the

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Fig. IV.



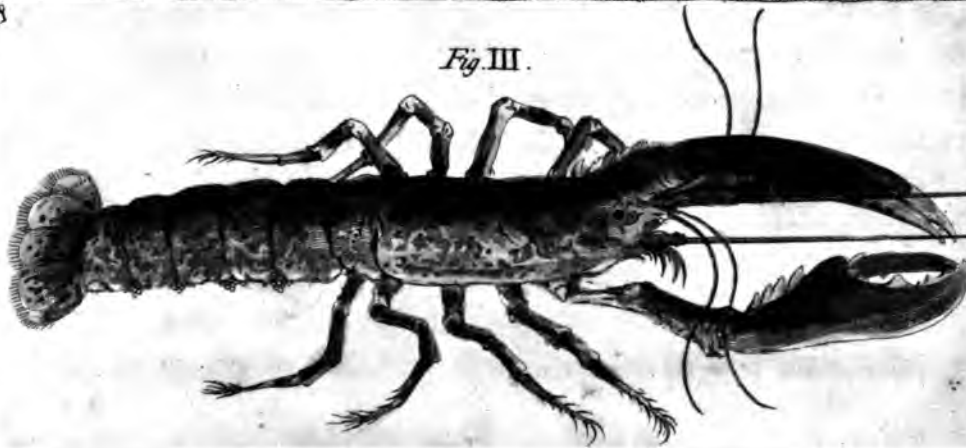
Fig. I.



Fig. II.



Fig. III.



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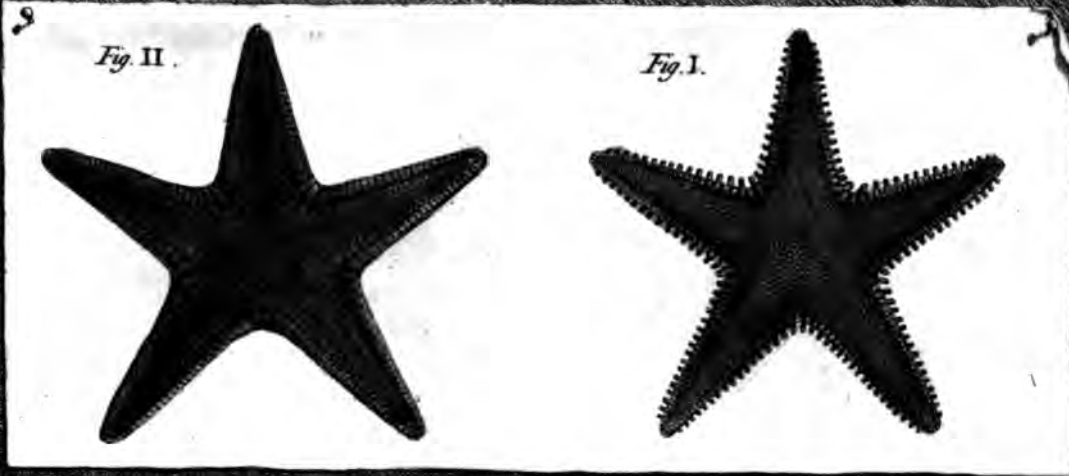
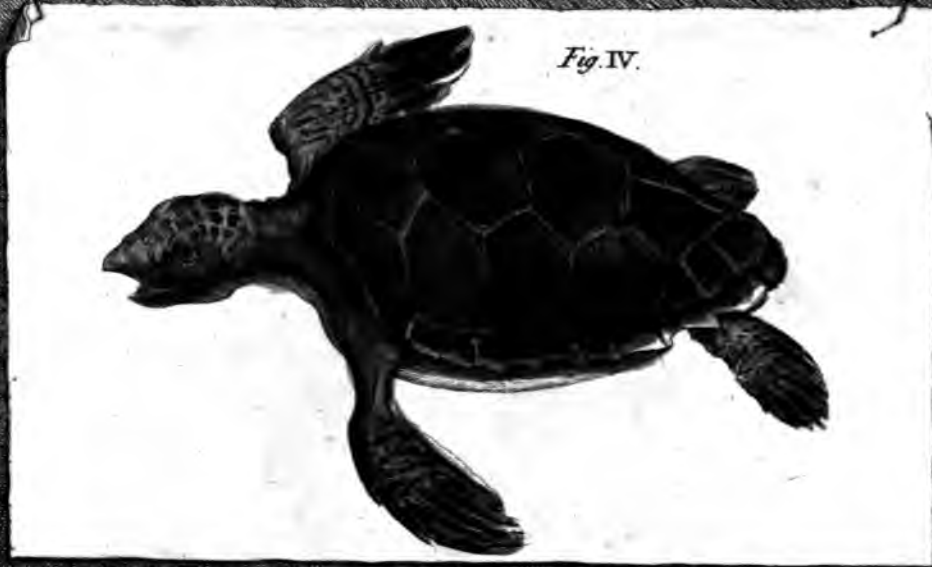
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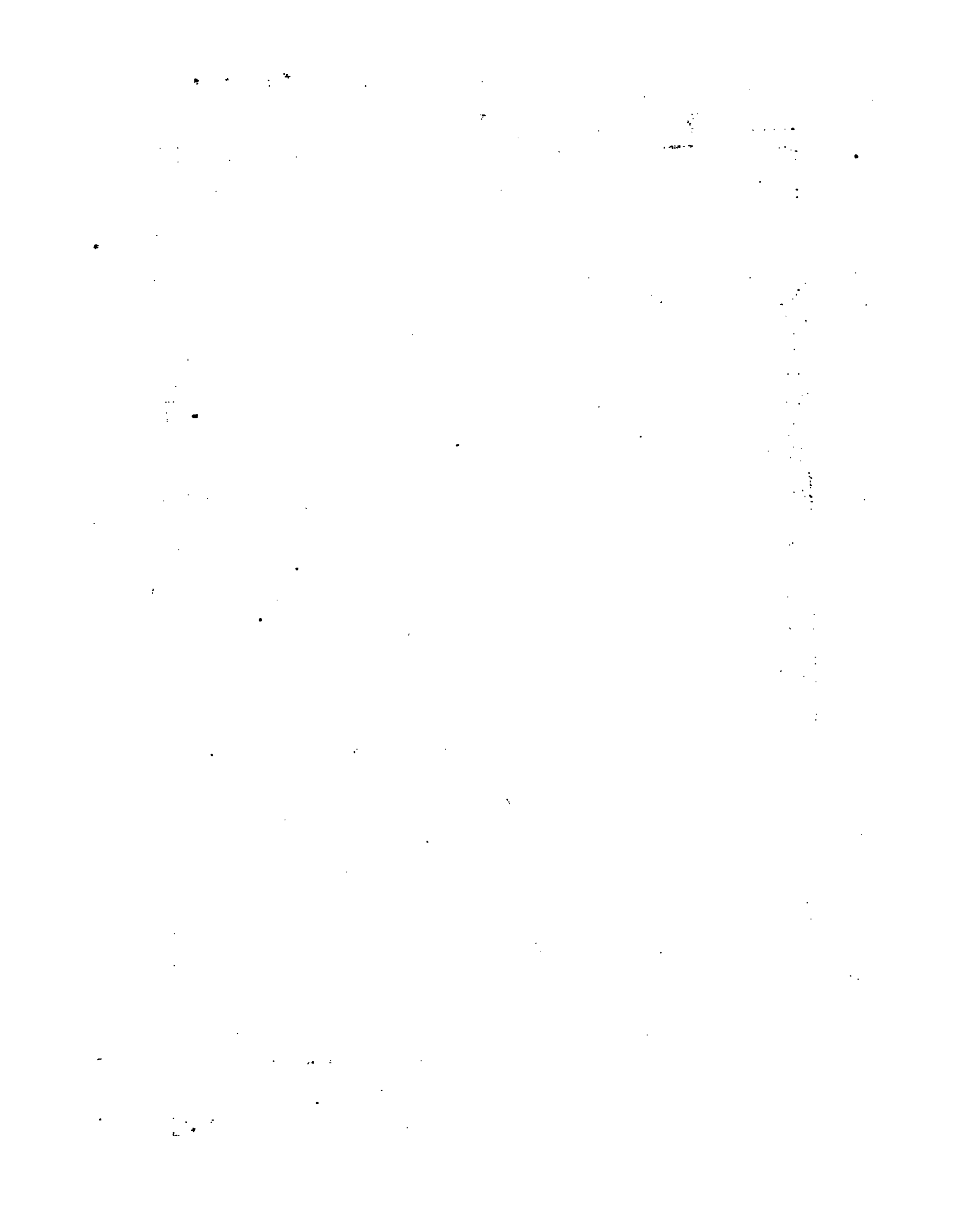
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the Thoughts of Authors, who themselves might have been imposed upon. The great *Willoughby* indeed has given us undoubted Truths in his *Treatises of Birds and Fish*, which are generally allow'd the best Instructors for such as are disposed to study the Structure and Nature of those Creatures, to which I refer my Reader. I shall now proceed to speak of those *Quadrupedes* which are the nearest related to the *Scaley* Tribe.

Explanation of the Figures relating to this Chapter.

P L A T E III.

- Fig. I. *The Muscle.*
- Fig. II. *The Scallop, whose Motion is perpendicular.*
- Fig. III. *The Lobster lying in its natural Position.*
- Fig. IV. *The large Sea-Crab.*

P L A T E IV.

- Fig. I. *The Upper-side of the Star-Fish most common upon our English Coast.*
- Fig. II. *The Under-side of the same Fish.*
- Fig. III. *The Shell-Fish call'd the Sea-Horse, found upon the Coast of Italy; taken from the Royal Society.*
- Fig. IV. *The Turtle, or Sea-Tortoise, cloathed in Shell, the first of the finny Race; drawn from Mr. Salter's Collection at the Coffee-House at Chelsea.*

P L A T E V.

- Fig. I. *The Sword-Fish.*
- Fig. II. *The Saw-Fish.*
- Fig. III. *The Mermaid, or Syren.*
- N. B. *All this Plate taken from Mr. Salter's Coffee-House at Chelsea.*

P L A T E

P L A T E VI.

- Fig. I. *The Orbis Echinatus; from Mr. Salter's.*
 Fig. II. *The Whiting.*
 Fig. III. *The Silver Eel, whereby the Difference between the Smooth Fish and the Squameous Kinds may be observed.*

P L A T E VII.

- Fig. I. *The Roach, which may serve to give a general Idea of the Squameous or Scaly Fish.*
 Fig. II. *The Flounder, or first of the flat Fish. In this Kind it is remarkable that the Males have their Mouths on the right Sides of their Bodies, and the Females on the left.*
 Fig. III. *The Thornback, shewing its upper and lower Sides.*

P L A T E VIII.

- Fig. I. *The Flying-Fish; from the Royal Society.*
 Fig. II. *The Nest of the Tickleback observed by Mr. Hall.*
 Fig. III. *The Nests or Cases of four several Kinds of Cados-Worms found in the Waters.*



C H A P.

Fig. I.

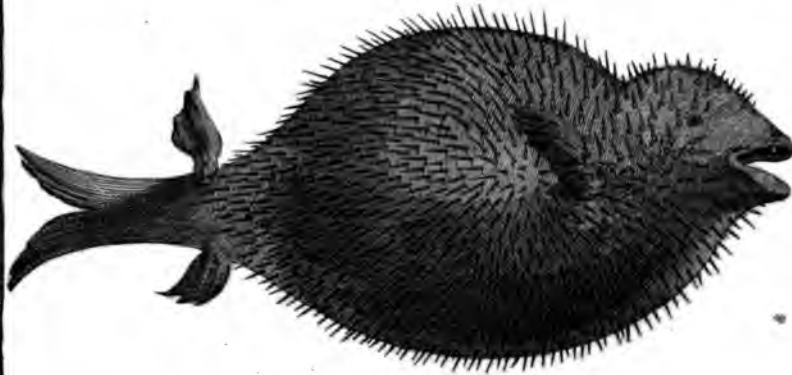


Fig. II.



Fig. III.



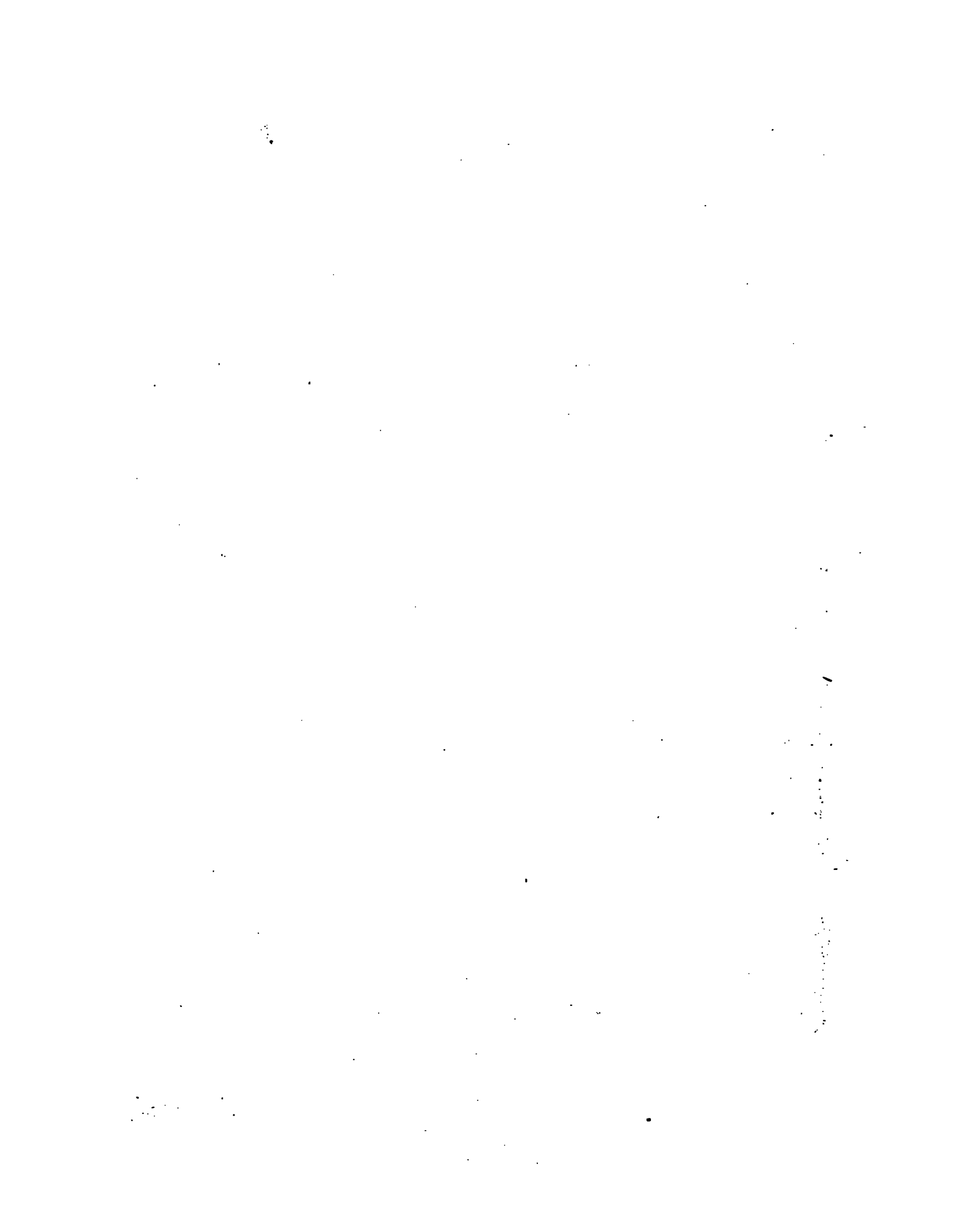


Fig. III.

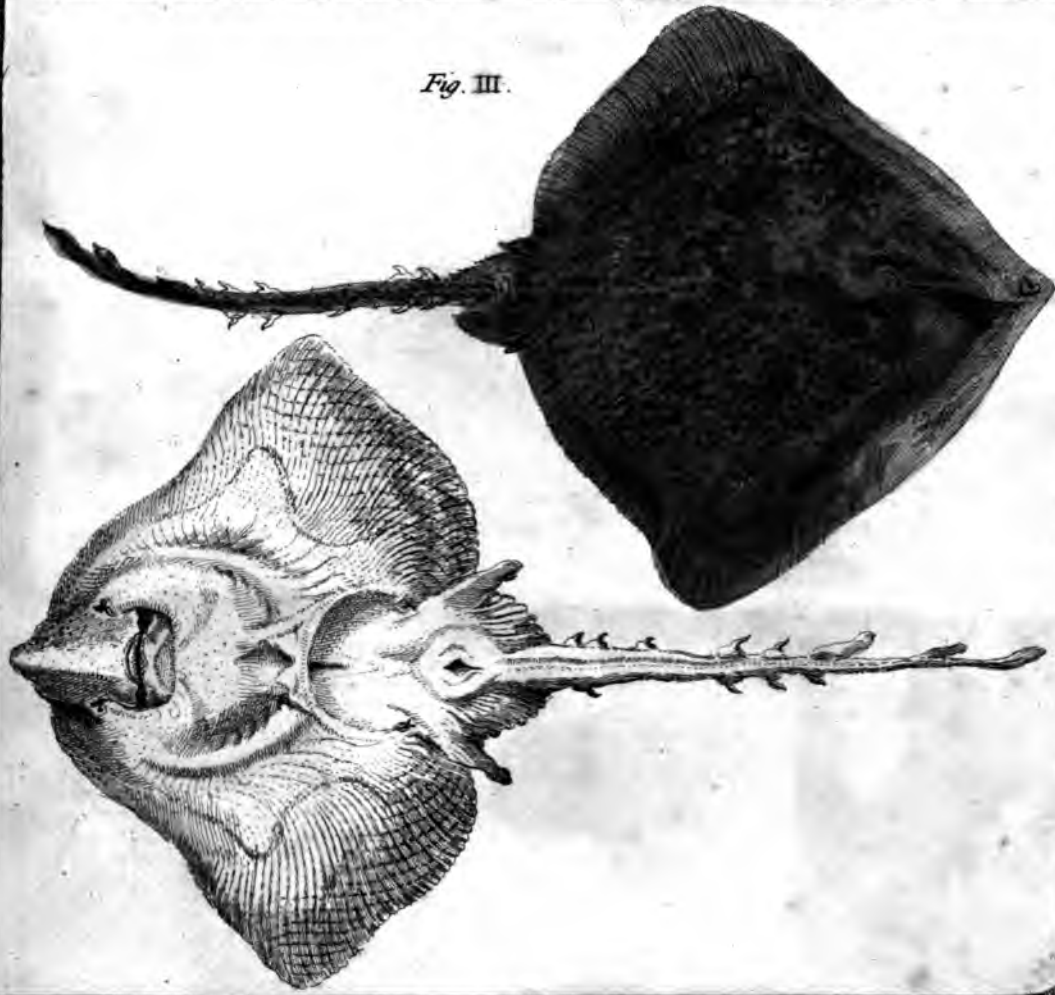
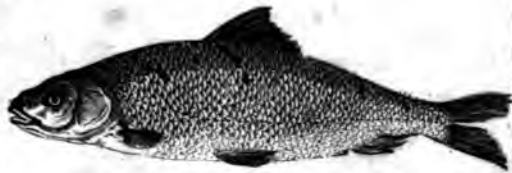


Fig. II.



Fig. I.



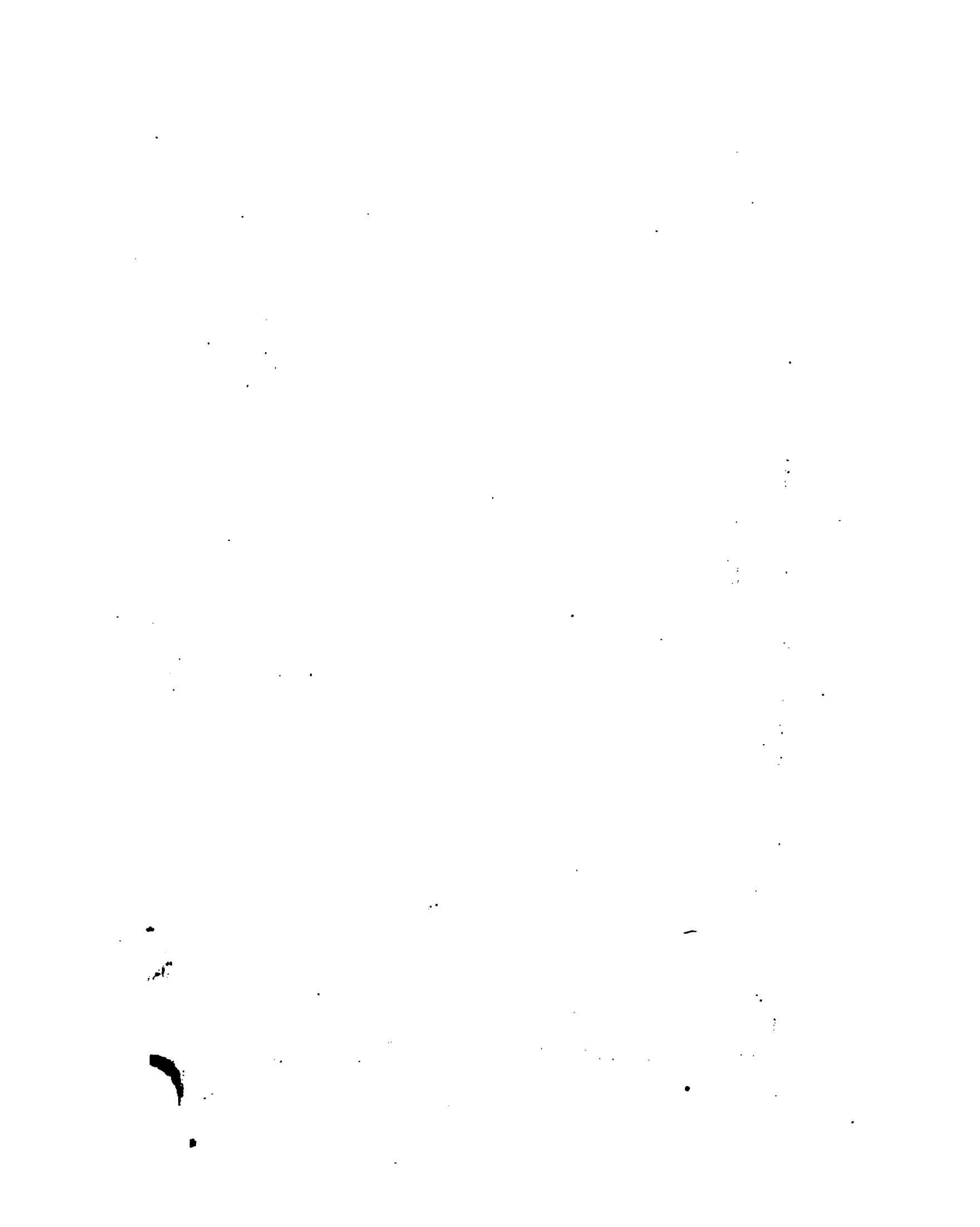


Fig. I

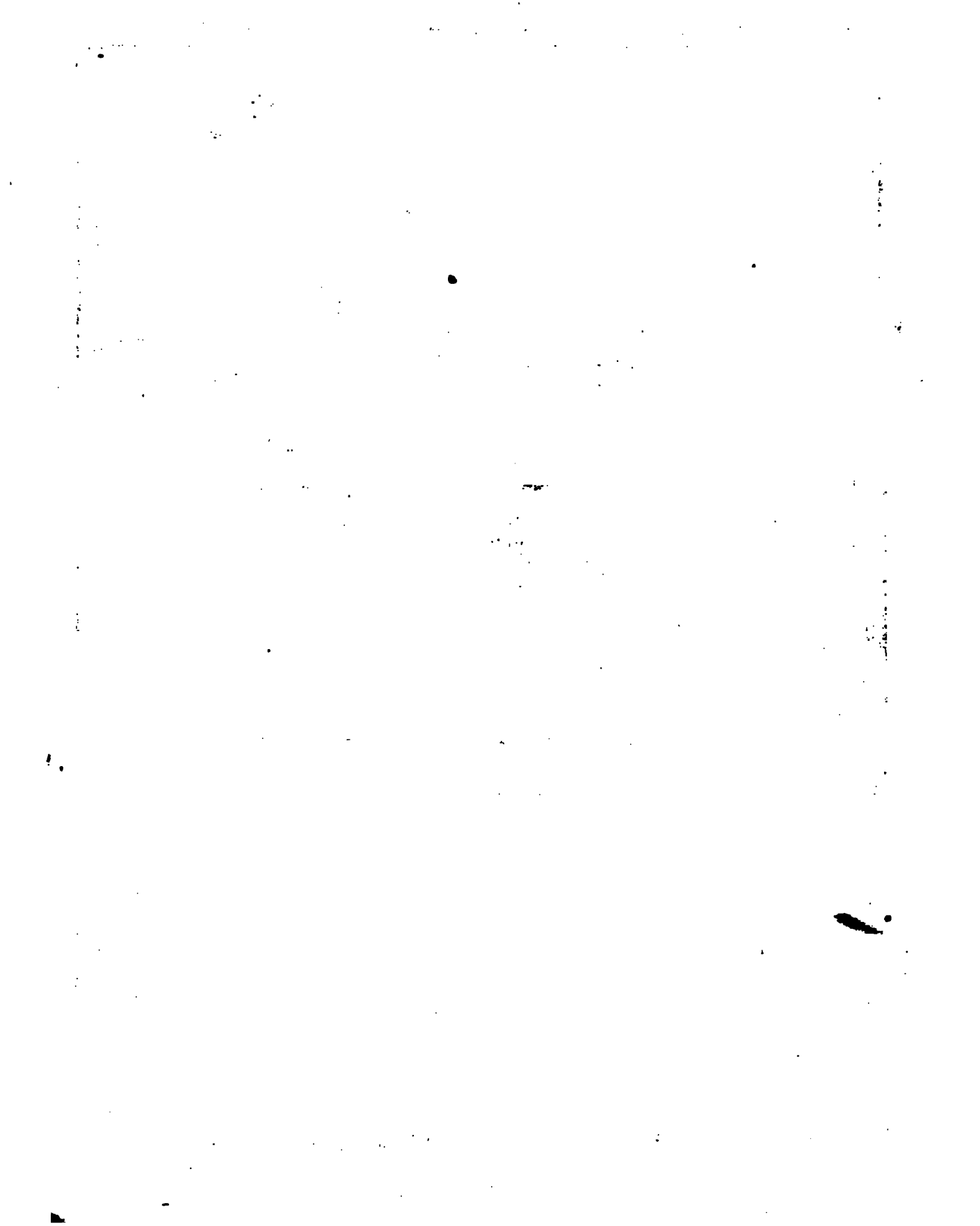


Fig. II



Fig. III





C H A P. V. and VI.

Of SERPENTS, *the CROCODILE, LIZARD, CAMELION, and others of the Scaly Tribe, which are Amphibious, and Inhabitants of the Land; and of FLYING LIZARDS, &c. which seem to be the immediate Passage between the Fish and Bird kind.*

AS the foregoing Chapter treats of such Creatures of the Waters as are generally cloathed in *Scales*, I can nowhere so properly introduce the Race of *Serpents, Snakes, &c.* as in this place: these seem to possess many Particulars found in *Fish*; as the manner of placing their *Scales*; their *Eel-like Motion*; but above all, their Degree of Life. As I have taken notice above of the extraordinary Motion of every *Muscle* of an *Eel*, and some other *Fish*, after they are cut to pieces; so such Motion is no less remarkable in some *Snakes* and *Serpents*, after their Bodies are divided into several Parts. And the Food likewise of our common *Snakes* is much the same with that of our *River Eels*, they both feeding upon *Frogs, Toads*, and such like.

Of this Race I do not find above three sorts in *England*, viz. the *Snake*, the *Viper*, and the *Slough-Worm*. The first is an harmless Creature, as far as I can observe, tho' many believe the contrary: For this Year I have had several alive, which have been familiar about the House, without doing any hurt; tho' some have taken them into their Bosom. I have heard that what Poison they have lies about their Tongue, but that they lose it the first Dart they make at any thing they are angry with, and can never recover it again till they get to Water: But if it was

was so, I believe People would hardly venture to take them up carelessly in the Fields, as I have seen several times. The *Viper* indeed has a deadly Poison lodged in little Bladders about the Root of its Fangs; but his whole Body besides is a Dainty, eaten very frequently. The learned Dr. *Tyson* tells us in his Account of the Dissection of a *Rattle-Snake*, *Phil. Transf.* N^o 144, that the *Male Viper* has four *Penes*, agreeing in most Particulars with the *Penes* of the *Male Rattle-Snake*, which are likewise four in number, altho' the *Females* of both Kinds have each of them only two *Uteri* for receiving them. He conjectures that two of these *Male* Parts enter at one time into one *Uterus*, and spread themselves like the *Pythagorean Y*, that they may the better and more firmly be retained there till they have performed their Duty. He tells us that both the *Rattle-Snake* and the *Viper* are *Viviparous*; but the common *Snakes* we all know are *Oviparous*; their *Eggs* being frequently found in Dung-hills.

The same Gentleman gives us a long Detail of the several Parts *External* and *Internal* of the *Rattle-Snake*, which he dissected at the Repository of the Royal Society in *January 1687*, illustrated with many extraordinary Observations, which I refer my Readers to, as well as the curious Cuts which he has prefix'd to the above Transaction. In Plate IX of this Work I have given a Cut of one of those *Rattle-Snakes*, now in the Repository of our Royal Society; and in the same Plate I have given likewise a Figure of another Kind of *Serpent*, as well to shew the different Frame of the Heads of various Kinds of *Serpents*, as to give my Reader the Satisfaction of observing the surprizing Variety of Colours, and different Methods of their Scaling.

In the Cabinets of the Curious we may find vast Varieties of the *Serpent* Kind; but I think none of them can be more remarkable than that presented to the Royal Society the last Year by Dr. *Mead*, which is above five and twenty Foot long, and is now preserved in their *Museum*: The Body in the thickest part,
altho'

altho' it is now dry, measures about ten Inches diameter; and I believe is one of the largest sorts produced in the *East Indies*.

Immediately after this Race follows the *Crocodile*, *Allegator*, *Lizard*, &c. which are covered with *Scales* like the former, placed conveniently in the *Lizard* Kind, for the easy bending of their Bodies: The Shape of their Heads is agreeable to the Figure of the Heads in *Snakes*, and they are *Oviparous*; but for the Assistance of their Motion upon the Land, Nature has added to their Bodies four Branches or Legs a-piece. Their Habitation is partly in the Waters, and partly upon the Land: The first agreeing with the *Fish* Kind; and the latter, as well as the Legs they are endow'd with, make them Partakers with *Land Animals*.

We have Accounts of *Crocodiles* and *Allegators* of above twenty Foot in length; and I am of Opinion that some of these Creatures having been formerly in *England*, has given Rise to the many fabulous Accounts, which have been handed down even to our Times, of *Dragons*; and this I the more readily believe, because the Skeletons of some such Creatures, or the Impressions of them in Stone, or other *Mineral* Matter, have been dug in several Parts of this Kingdom; which shows plainly that there have been such Creatures in this Island.

The *Lizard* Kind is very numerous, and I question not but there is as great Variety of them as there is of the *Serpent* Race. Upon *Hamstead Heath* I have observed a small sort of them of a brownish Colour, perching upon the *Furze* and *Broom* growing there; and I have heard of a small green sort likewise in *England*, but have not seen it.

The *Water-Neutes* are almost of the same Figure, and are said by some to be poisonous; tho' I have handled them very often, without receiving any Injury from them. We have besides these a larger kind, found commonly in moist shady Places, which are black on their Back, and have yellow speckled Bellies; and these likewise I do not

find have any Venom in them. These two last Kinds lay *Eggs* about eight or ten in number, and the *Crocodiles* and *Lizard* Kind are said to do the same; and none of these, as I can learn, either feed or suckle their Young, but leave them to shift for themselves as soon as they are hatcht. The Natural Historians have given us large Accounts of these Creatures, which I refer my Reader to for his further Satisfaction.

The *Camelion* is a Creature, whose Figure is near enough to those of the foregoing Race, to accompany them in this Chapter; but its Life and Habitation is altogether upon the Land: its Skin is Shagreen'd, like that of the *Dog-Fish*, and transparent; so that sometimes one may perceive through it different Colours, as its Body happens to be in a different State. This Creature has been reported to live upon the Air only; but those among the Curious, who have kept them alive, tell us, that their chief Food consists of *Flies*, which they catch, by darting out their Tongue with great Quickness. All the *Animals* which I have yet mention'd in this Chapter are said to sleep, or are laid up, in the Winter.

The Creature which seems to be next ally'd to the foregoing Race, is the *Wing'd* or *Flying Lizard*, whose Shape and Turn of Body, in many Respects, is like that of the small *Italian brown Lizard*, or that sort found upon *Hamstead Heath*: the *Wing'd* Part of it is in Substance much like the *Wing* of a *Batt*, but the Head is different from that of the *Lizard* Race; and the *Pouch* under the Throat I am told contains a poisonous Matter. This kind of *Flying Lizard*, which I have delineated in Plate IX. Fig. V. was presented me by Dr. *Ruysh* of *Amsterdam*, who received it with other Rarities from the *East Indies*: And the same Kind may be observ'd in the Cabinets of Sir *Hans Sloane*, Mr. *Vincent* of *Harlem*, Dr. *Ruysh* and Mr. *Seba* of *Amsterdam*.

In

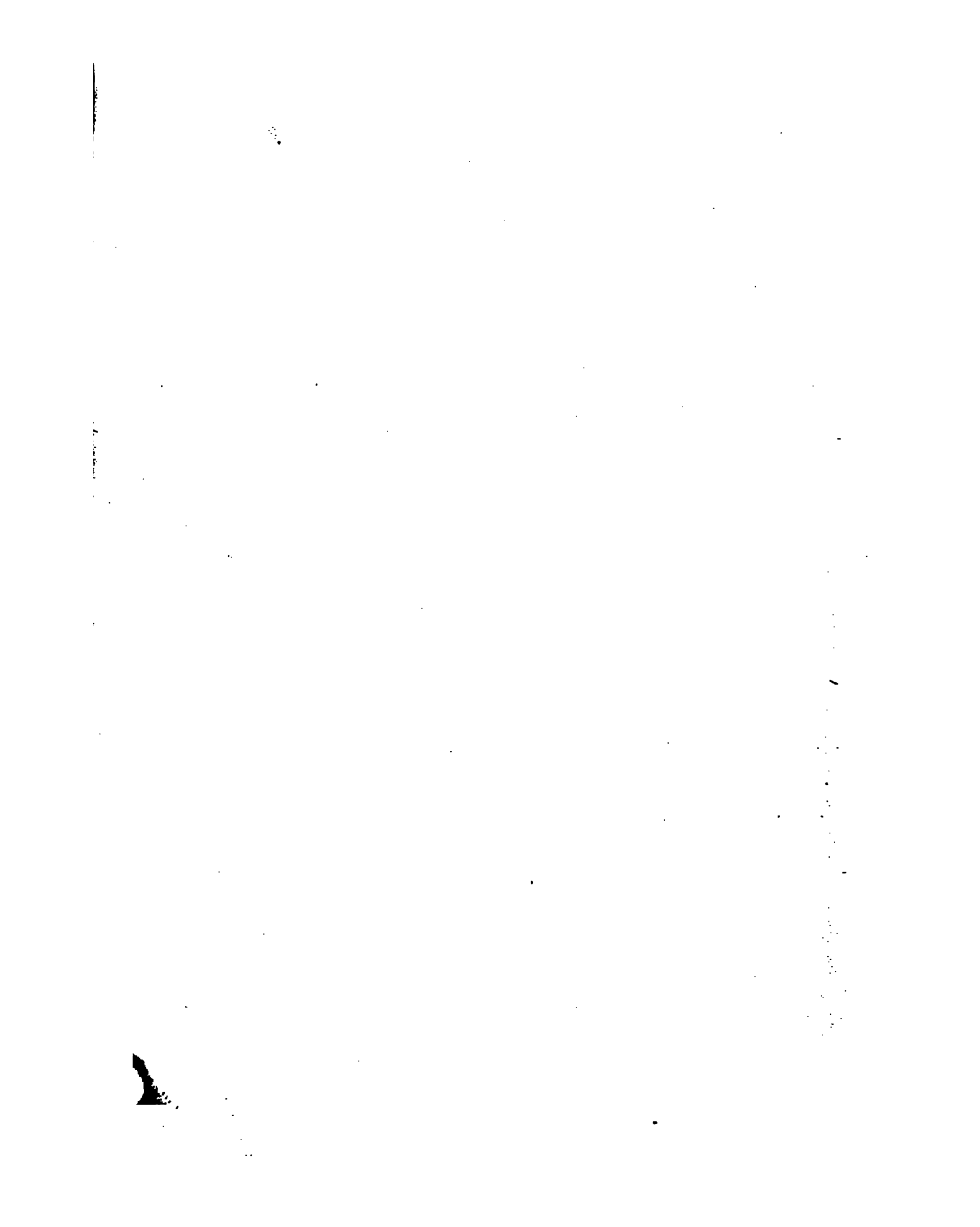


Fig. III.

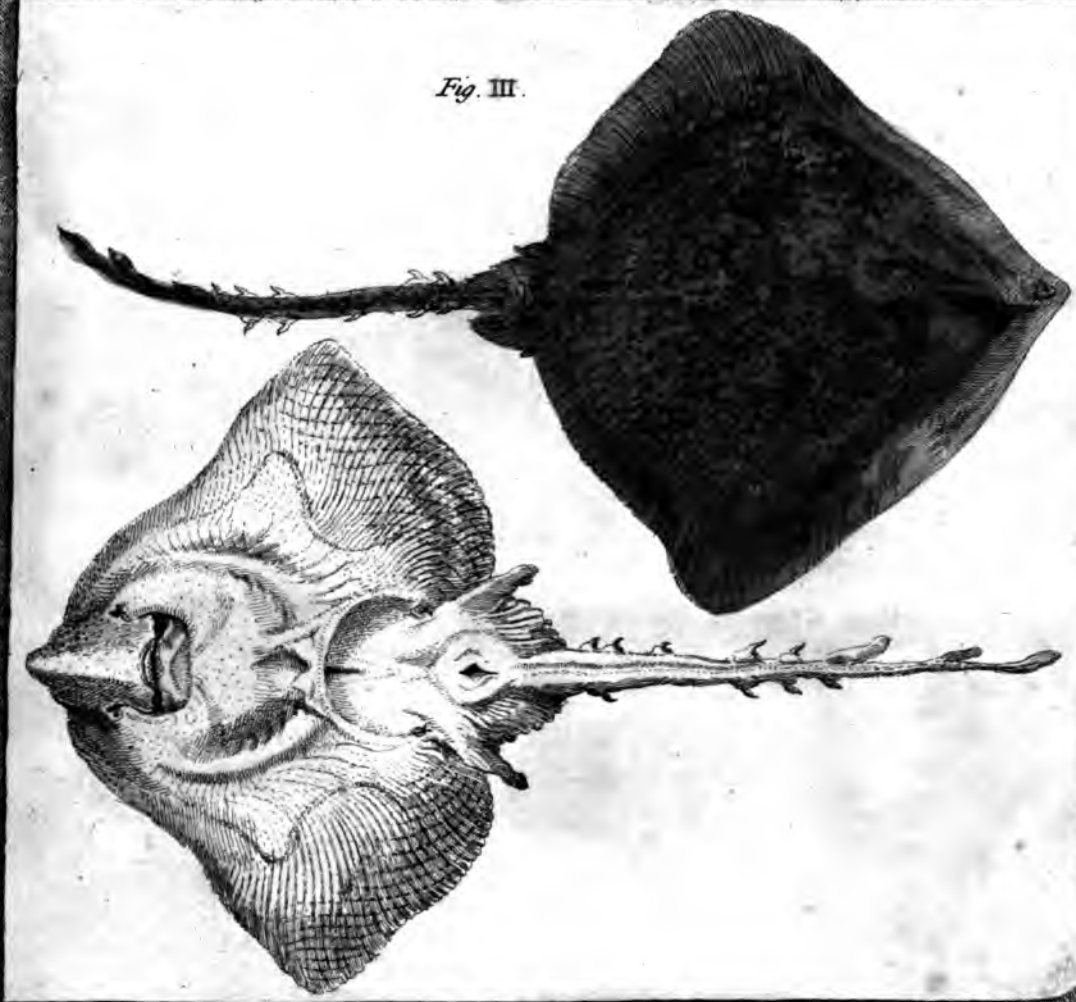


Fig. II.



Fig. I.



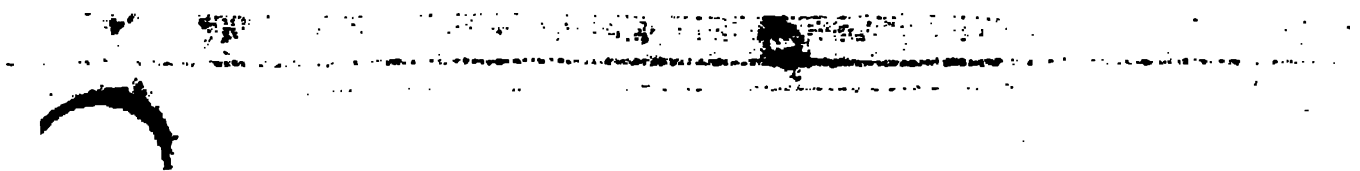


Fig. I



Fig. II



Fig. III



C H A P. VII. and VIII.

Of BIRDS and FOWLS; as also of the BATT
(or Fluttermouse) FLYING SQUIRRELS, &c.
which seem to be the Passage between Fowls and
Four-footed Beasts.

IN this Chapter I shall treat of such *Animals* as are cloathed with *Feathers*, and in many Respects agree with the last mention'd *Animals*, which are, like *Birds*, *Oviparous*, have four Branches to their Bodies, and possess the Power of Flight. To which we may likewise add that remarkable Analogy, which there is between some Kinds of *Birds* and the *Animals* mentioned in the preceding Chapter, which lay themselves up, or sleep, during the Winter.

The *Birds* which have this kind of Rest, and are lost to us, during the Winter Season, are *Swallows*, *Martins*, *Swifts*, *Cuckows*, *Nightingales*, and some others; and as the Spring Season is more or less temperate, so does it influence the waking of these *Birds* from their State of Rest, as it does also all *Animals* that sleep the Winter. The *Cuckow* and *Nightingale* commonly begin to sing about the first Week in *April*, and the *Swallows*, *Martins* and *Swifts* appear about that time; nor is Nature less bounteous to all its Off-spring, when it rouses these Creatures from their Lethargy. The *Vegetables*, which the Winter-Frosts retrenched of their Beauties, are enliven'd, and display their usual Ornaments, and become an agreeable Shelter and Habitation for those *Birds* which are re-instated in Life. This Temperature of Air equally puts the Juices of all the *Sleepers*, whether *Animals* or *Vegetables*, into Motion; and if such a Temperature of Air happens to reign for any time before the natural Season,

son, it has the same Effect upon their Bodies, and rouses them from their Lethargy. It is remarkable, that this Year (1719) we had no Frost or Snow of any Continuance in *England*, unless in the most Inland Parts. The Softness of the Weather in *January* and *February* was such as produced the Effect I mention, of waking these *Birds* before their Time. In *Lincolnshire*, and the adjacent Counties lying next the Sea, several *Cuckows* were seen and heard to sing in the first fifteen Days of *February*; some Hives of *Bees* swarmed about the same time; and *Batts* were flying about, as they do commonly in Summer Evenings; but a cold Easterly Wind coming, soon afterward put them to Rest again. These *Birds*, which sleep the Winter, have certain Periods of Time in the Summer, when they are lost to us. About the middle of *June*, *Nightingales* and *Cuckows* have finished their Song, and are seen no more till the following Spring. Indeed, as a Matter of Curiosity, I have known *Nightingales* kept in Cages for two or three Years together; and if they have been set in warm Places they have sung at *Christmas*. There is now a Person living in *Fetter-lane*, *London*, who is never without them; and at a Coffee-House near his Royal Highness the Prince of *Wales's* Court in *Leicester-fields*, there is now one of them.

Birds differ from four-footed Beasts in the manner of their Generation, and bringing forth of their Young: In these the *Female* has only one Cluster of *Eggs*; but we always find two *Ovaries* in every *Female* of the four-footed Race. In *Birds* and *Fowls* the *Egg* is made fecund by the *Male*, before it is excluded from the Body of the *Female*; and every *Egg* in the Body of the *Female* has a Power of Growth, to a certain Magnitude, before it can be discharged from the *Hen*, even tho' she has not been in Company with a *Cock*: For I have often seen *Birds* that have been kept in Cages lay *Eggs* in *April*, altho' they have not so much as seen a *Male* of their own Kind; but these *Eggs* were not prolifick, altho' the *Hen* has set upon 'em above a Month.

ling of one which is of the natural Colour, with one of the *White* sort, is the Cause that in the Breed or Increase some are *Mottled*, others *White*, and rarely any of the natural Colour, especially (as I observe) if the *Cock* was *White*. I think we may lay it down as a Maxim, that where-ever *Whiteness* is seen in the *Feathers* of *Fowls*, *Hairs* of *Beasts*, and *Leaves* or *Flowers* of *Plants*, it proceeds from Weakness, or want of Nourishment, in the Bodies they grow upon.

It is worthy our Observation, the Contrivance of *Birds* in the Building of their *Nests*; how every distinct Species hath a Method peculiar to it self in preparing its Lodging, not only as to the Curiosity of its Frame, but the Choice of certain Materials of which it is composed; and even its Situation is not less regarded by them. The Form of a *Martin's Nest* is wonderful, as well if we consider how every part of *Clay* or *Mud* is brought in little Particles to make the whole; as also the Position of those *Nests* under Shelter of some Pent-house, or horizontal Covering, to keep them from the Injuries of the Weather. As to the Form of the *Nest*, 'tis like a Cup pointed at the Bottom, with a small Hole or Notch towards the Brim pointing to the East to go in at, and the Inside is lined with *Feathers*, to make it easy for their Setting. The *Magpye* is likewise as careful to preserve its Young from the Injuries of the Weather and *Birds* of Prey as the *Martin*; but Nature has given him a different kind of Cunning, his *Nest* is guarded on all sides with *Thorns*, and lined with *Mud*, which he smooths beyond the Guess of any one that has not seen it.

The *Nests* of other *Birds* are every one as remarkable as these we have already mentioned. 'Tis I think impossible any one can pass by the Works of these little Creatures without admiring the Delicacy of their Composition, and Beauty of their Contrivance; and particularly some of those *Birds Nests* which are so common in the *West Indies*, which are fastned to the Ends of tender *Twigs*,
and

Fig. I



Fig. II



Fig. III



that manner with his Hands, that some Words he was appointed to speak were plain enough pronounced to be understood; and I conceive it is no difficult Matter to bring any *Dog* to speak some Words, if we make use of the same Means: But *Birds* repeat Words distinctly without any Assistance of this kind.

The *Wings* of *Birds* answer to the Fore-feet of *Beasts*, so far as to make up the four Branches of the Body; and in the Motion of *Birds* upon the Ground, assist them to move forward with greater Swiftness, as well as serve them for Flight. The *Quills* and larger *Feathers* of the *Wings* are remarkably different from those on the rest of their Body, and seem to bear the same Proportion with the other *Feathers*, that *Trees* do to *Plants* of an under Race. The other remarkable Parts of *Birds*, wherein they differ from *Quadrupedes*, are their *Beaks* or *Bills*, which are all of a Horny Substance, some long and pointed, as in the *Kingfisher*, *Woodcock*, *Snipe*, &c. others sharp and short, as in *Nightingales*, *Linnets*, and other *Birds* of piercing Note. Others again have clubbed *Bills*, as the *Bullfinch*, &c. some hook'd *Bills*, as *Hawks*, *Owls*, *Parrots*, which give them a hollow Voice; and in most *Water Fowl* flat *Bills* seem to prevail, as in the *Swan*, *Goose*, *Duck*, &c. As the *Beaks* of them are various, so do their Notes or Voices all differ just in the same manner that *Quadrupedes* differ in the Tones of their Voices, by having their Mouths or Organs of Sound of various Makes.

The *Legs* of *Birds* are all of them covered with *Scales*; and as to the number of *Toes*, I think they are generally the same, viz. three on each *Foot* with a *Heel*: The *Ostridge* indeed has but two; but these are all pointed with *Claws*, the which, as well as the *Scales*, are of different Make and Colour, as the *Fowls* or *Birds* they relate to are different in the other Particulars of their Bodies. But we may take notice likewise that Nature was not unmindful of the Uses of these Parts when they were first framed. To the *Birds* of Prey she has given *Talons*, for the better taking

king an dmanaging of their Food: And to such *Birds* as are inclinable to perch, she has been no less benevolent and careful in the Frame of their *Claws*; so likewise the *Fowls* both of the Waters and the Land are not unprovided of such Means, as only her own Wisdom could contrive the Model of for their Swimming and Walking.

The *Tail Feathers* of *Birds* are disposed proportionably to each Kind to assist in their respective Flights, chiefly by helping them to rise from the Ground, and serve as Rudders to guide their Bodies in the Air.

The Movement of *Birds* upon the Ground is of two Kinds. *Crows*, *Larks*, *Water-Wagtails*, and all the *Fowls* of both Land and Water set one *Leg* before the other: *Sparrows*, *Goldfinches*, and the greatest part of the *Bird* Kind jump from place to place. All the *Birds* that have fallen under my Observation drink Water; but there are some four-footed Beasts that never drink, as the *Hare*, *Coney*, and some others. 'Tis reported that the *Camel* will travel three Weeks without drinking; but see more of this in the Chapter of *Quadrupedes*.

The Food of *Birds* is of various Kinds, some preying upon *Birds*, others feeding upon *Carrion*, others upon *Fish*; but the greatest part upon *Fruit*, *Grain*, and *Insects*. The *Eagle*, and all of the *Hawk* Kind, with admirable Artifice take their Prey: And *Ravens*, as if their Smelling was the chief of their Senses, will follow *Carrion* many Miles; and the *Stork*, *Heron*, and all the *Water Fowls* are endued with no less Sagacity and Contrivance in catching of *Fish*, which is their proper Food. *Sparrows* and other *Birds* of the lower Class, flock together in Corn-Fields and Gardens, where the *Corn*, or other *Grain* or *Fruit* is fit for their eating: Others are no less vigilant and watchful to destroy *Caterpillers*, and such like *Insects*, where they are in any plenty. From hence we may reasonably conjecture, that the Cause of *Birds* passing from one Country to another, is to meet

with their proper Food. For in the same Climate or Country it is impossible to find a continued Store of *Insects* or *Grain* from the Beginning to the End of the Year for them to feed upon.

The *Birds* of Passage are the *Wood-Cock*, *Quail*, *Wind Thrush*, *Fieldfare*, *Stork*, and some others; though the Season of their Passing is different. The *Woodcock*, *Red Wing*, and *Fieldfare*, make these Parts their Refuge in the Winter, and are rarely found here after the Frost is over; tho' I have been informed there have been *Nests* of young *Woodcocks* taken about *Tunbridge*; and I was once Eye-witness of a Brace of these *Birds* taken in their *Nest* about the Middle of *May*; but I suppose the old ones had been wounded, and could not change their Station. About the Time these *Birds* commonly leave us, the *Quails* present themselves; and about the same time in *Holland*, and some other Places in *Europe*, the *Storks* return to their *Nests*. Upon this Subject of the Passing of the *Stork*, I have lately received a curious Letter, which I shall here insert for the Entertainment of my Reader, as it agrees perfectly with what I observ'd of that *Bird* when I was in *Holland*.

S I R,

Being lately in *Holland*, I enquired as much as I could of the People, concerning the Coming and Departure of those *Storks*, which I there saw in such great Numbers: The Account the People (especially at *Harlem*) gave me was this, That the *Storks* having bred, and the Young flying about with them, at the End of September, or thereabouts, as the Heat of the Summer more or less continues, these *Storks* gather together (in the Peoples Opinion, almost to a Bird) about a great Piece of *Marshy* Ground, there called *Harlem Meer*; being all assembled, they remain there several Days Chattering and Snapping with their Bills, till the last Birds are come to them in this Place of their Rendezvous. After this they make no more Noise; but in a little time
they

they all rise slowly together, soaring up in a great Flock and Body, making in the Air as they soar up several Rounds and Circles, till by degrees this great Flock of Birds, which at its first Rise almost darkens the Air, goes gradually higher and higher, till at last they appear to be in a manner but a Point, and so disappear till the next Spring they visit them again. I am, &c.

The *Eggs* of *Birds* are as remarkably different from one another as the *Birds* themselves, and seem to keep a just Proportion with the *Birds* or *Fowls* that laid them. Their Spots and Variations of several Colours are as worthy our Remark, as the *Feathering* of their Mother *Fowls*. The Number of *Eggs* laid by each Kind is for the most part constant: *Birds* especially seldom exceed five or six in number, unless it be the *Tom Tit* and *Wren*; which sometimes lay about twelve a-piece; but *Fowls* commonly exceed that Number. It is remarkable, that if we take away the *Eggs* of *Fowls*, they will still continue to lay to the Number of thirty or forty *Eggs*; so that they seem to have a discretionary Power of stopping when they have laid as many as they can set upon; or if they should happen to be spoiled by any Accident, they have a natural Freedom, whereby they can renew and make good their lost Clutch of *Eggs*. *Sparrows* and other *Birds* which are familiar about Houses, will sometimes breed three times in a Year; and *Pidgeons*, if they are well fed, will breed eight or nine times in a Year. The Time of Setting is about three Weeks for *Birds* and common *Poultry*; but *Turkeys*, *Pheasants*, and some others do not hatch under a Month. It is possible to hatch *Eggs* of all Kinds, without the *Hen* setting upon them. I have my self experienced the Hatching of *Chickens*, by means of an artificial Heat, agreeable to that of the *Hen's* Body.

Thus have I remark'd what is most observable in the feathered Tribe; and that I may proceed gradually from these Creatures which have the Power of Flight, to the Race of *Quadrupedes*, or
four-

four-footed Beasts, I am obliged to take notice of the *Batt* or *Fluttermouse*, and *Flying Squirrels*, which seem to be the natural Passage between *Birds* and *Beasts*.

Of the *Batt* or *Fluttermouse* I have seen three Kinds, *viz.* the common sort frequent in *England*; one sort about one fourth bigger than the common, with Ears twisted like *Rams* Horns, about an Inch and half in measure; and a third Kind brought to us from the *West Indies*, whose Body is as large as a *Rat*, and the Wings being extended measure from Point to Point above two Foot. In these Creatures there is no remarkable Difference that I can remember, but the Size of their Parts.

These *Animals* partake of the four-footed Kinds in the Make of the Head, which agrees perfectly with those of the *Mouse* or *Rat* Kind; the Shape of the Trunk of their Bodies likewise is much the same, and are both cover'd with Hair. These *Animals* are also *Viviparous*, bringing forth their young ones perfectly formed (like *Quadrupedes*) and give them Suck.

They partake of the *Bird* Kind in having only two Legs, beside the Hooks at the Points of their Wings; they have also the Power of Flying, and sleep like *Swallows* in the Winter. I have found many of these in old Walls in the Winter, that have been quite void of Motion, and pressed together so close, that they hardly preserved their natural Figure; and yet these, as I was informed by several Persons, having been brought to a Fire, revived, and flew about the Room. The Note or Voice of these *Animals* is between the Chirping of *Birds* and the Cry of four-footed *Beasts*. These Creatures have not long Tails like *Animals* with four Feet.

I have not had the good Fortune to meet with a *Flying Squirrel* perfect enough to take a good Figure from; tho' there is one in the *Museum* of the Royal Society, which is enough to satisfy us that there is such an *Animal*, and shew us that it has not only the necessary Parts for Flight, but partakes so much of the *Quadrupede*,

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Fig. I



Fig. II



Fig. III



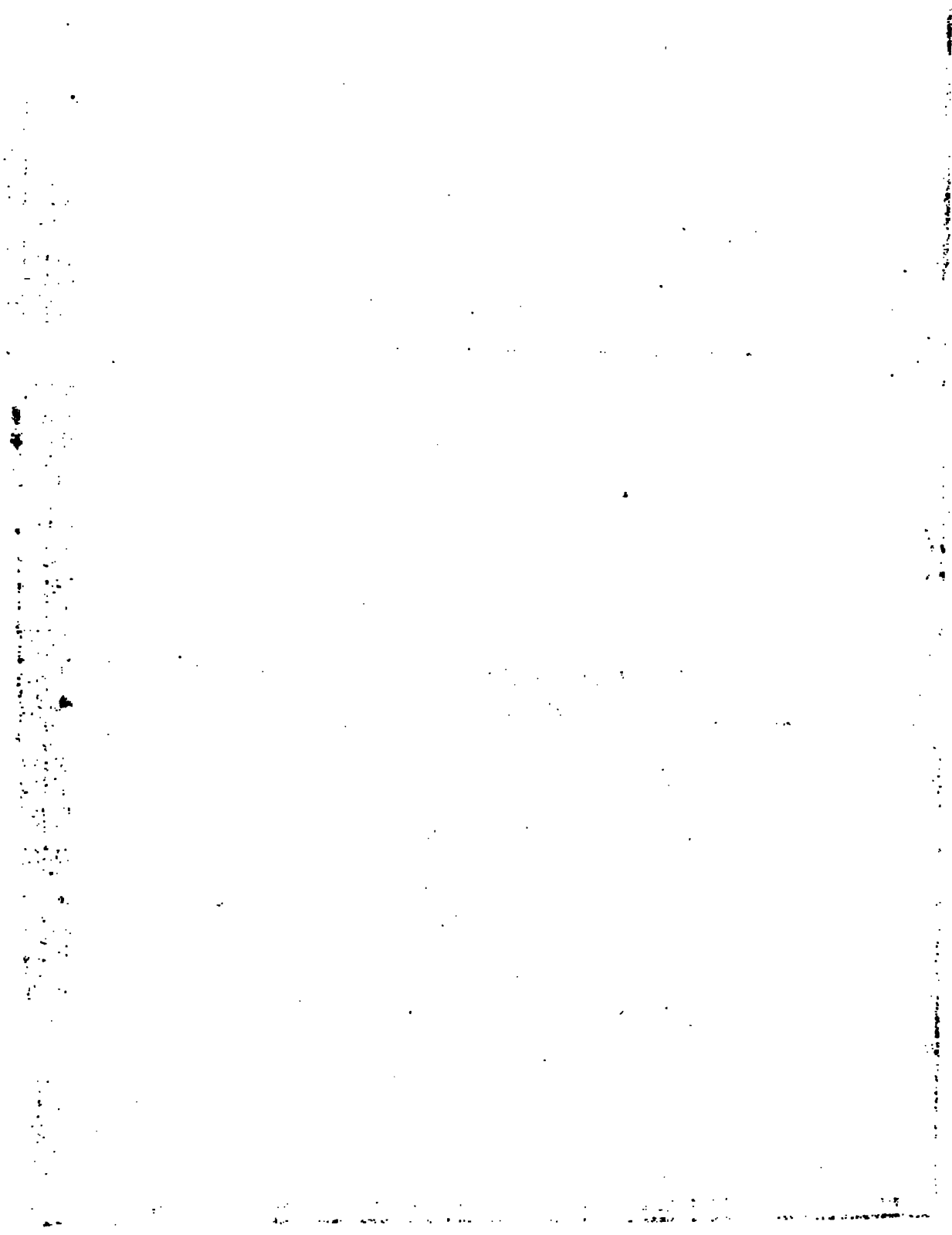


Fig. I



Fig. II



Fig. III



drupede, as may lead us to the Contemplation of four-footed Beasts, which is the Subject of the next Chapter.

Explanation of the Plates relating to this Chapter.

P L A T E X.

Fig. I. *The Head and Legs of a Linnet; the first shewing the manner of its Bill or Organs designed by Nature for the Utterance of the most piercing Note: The second shews the manner of its Legs and Claws disposed for Percking.*

Fig. II. *The Head and Legs of the Bullfinch, whose Beak is Clubbed, disposed for the Utterance of more hollow Notes.*

Fig. III. *The Head and Legs of a Hawk, wherein we may observe how Nature has disposed them for the Catching of its Prey.*

P L A T E XI.

Fig. I. *The Head and Legs of the Halcion, or Kings-fisher, which Parts are naturally disposed for Climbing and Catching its Food, which chiefly consists of Insects in the Bark of Trees, and Earth-Worms:*

Fig. II. *The Head and Legs of the Woodcock, whose Bill is contrived for searching for his Food in the Ground, such as Earth-Worms, &c.*

Fig. III. *The Head and Legs of a Goose, which may serve to give us an Idea of the same Parts in most Kind of Water-Fowl.*

N. B. *This and the foregoing Plate were drawn from Mr. Dandrige's Cabinet in Moorfields.*

P L A T E XII.

Fig. I. and II. *The Bird of Paradise in two Views; taken from the Royal Society.*

Fig. III. *A Bird of Paradise from Amboina; drawn from Dr. Ruysh's Cabinet at Amsterdam.*

P L A T E XIII.

Fig. I. *The Back of the common Batt, shewing wherein it relates to the Bird Kind, and what Affinity it has to Quadrupedes.*

Fig. II. *The Fore-part of the same Batt; from Mr. Dandridge's Cabinet.*

C H A P. IX.

Of QUADRUPEDES, or such ANIMALS of the Viviparous Race, as have four Legs or Branches to their Bodies.

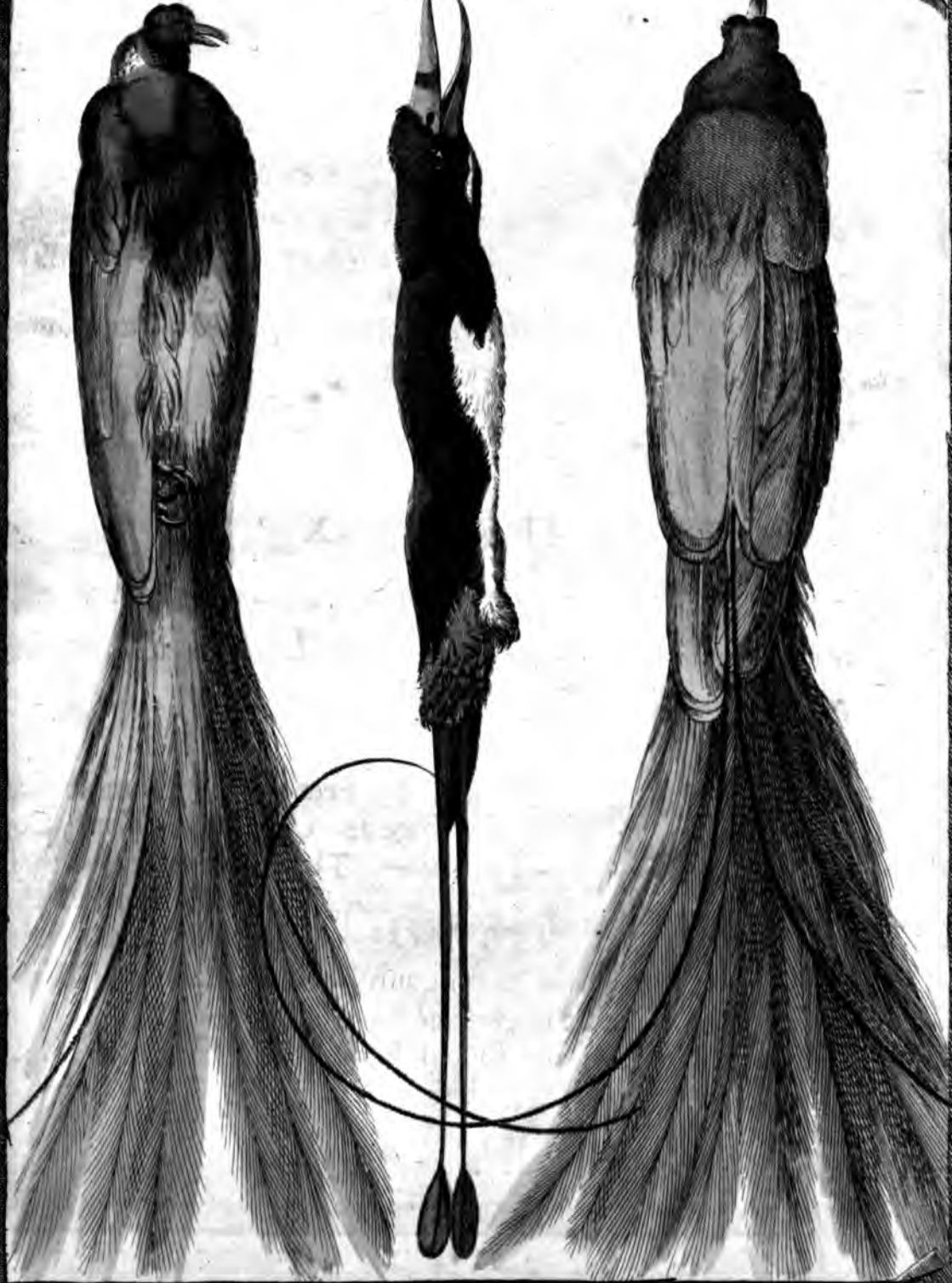
THE Tribe of *Animals* with four Feet are for the most part clothed with *Hair*; but some few only have a *Scaly* Covering, or else are clothed in *Spines*. The general Heads I shall range them under are, the *Tallon-footed*, the *Claw-footed*, the *Hoof-footed*, and the *double Hoof* or *Clowen-footed*: And again, those of the *Horned Race* I shall distinguish by the Characters of the *Perennial horn'd*, and the *Annual horn'd Beasts*.

The largest of the four-footed Race is the *Elephant*, and I think there is none smaller than the *Mouse*. The Method of Motion

Fig. I.

Fig. III.

Fig. II.



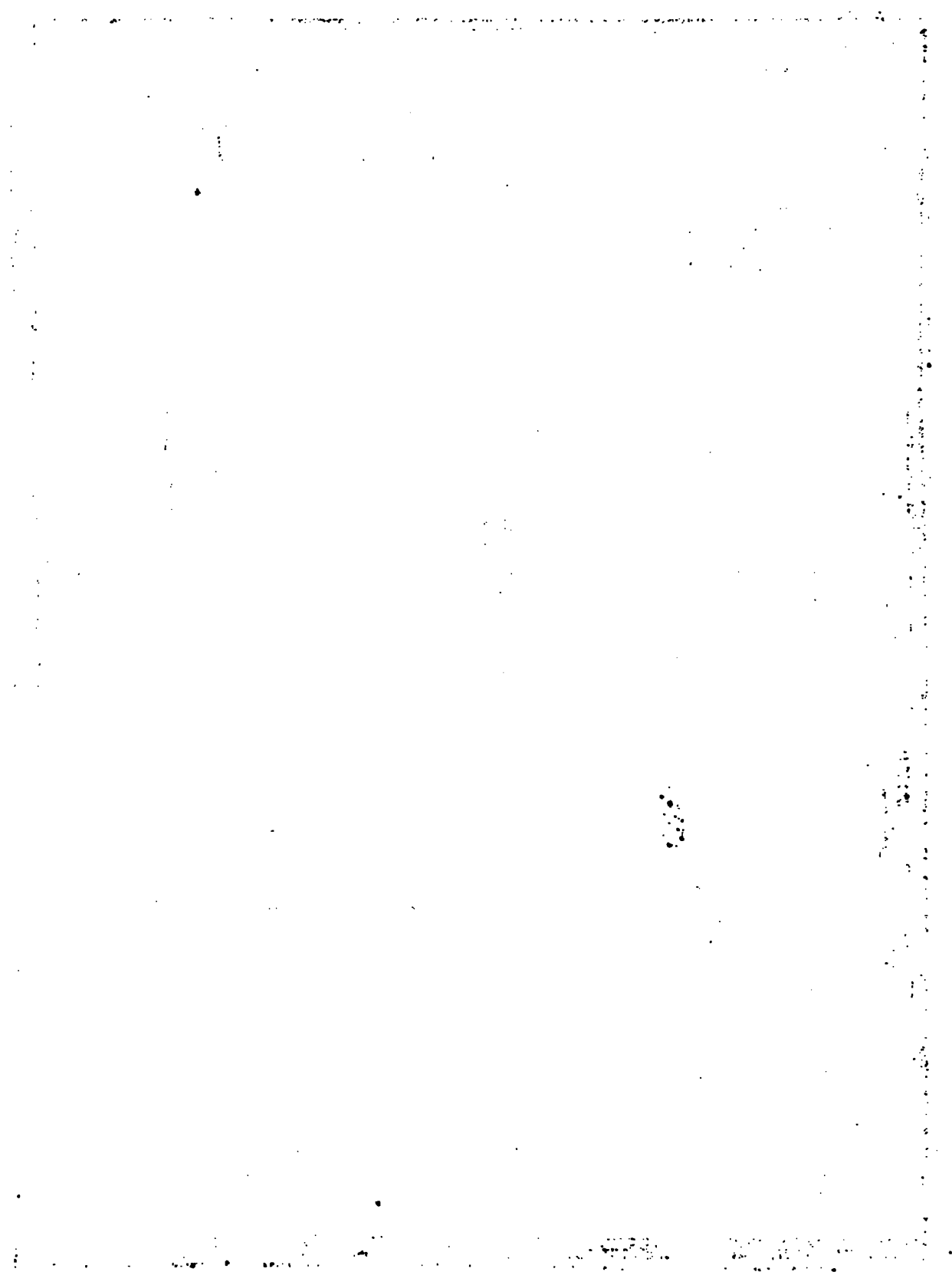


Fig. I.



Fig. II.





Motion in all this Tribe is horizontal, and to a few only is given the extraordinary Power of Climbing, by means of their sharp *Talons*, or by the Frame or Texture of their fore Feet, with which they can lay hold of the *Branches* of *Trees*, or whatever may be helpful to them for their Conveyance. The Walking of these Creatures is perform'd by moving the *Off-leg* before and *Near-leg* behind at one time, and following that Motion with the two contrary *Legs*; but in their Running they lift up at once their two *fore Legs*, and in the next Motion follow them with their *hind Legs*; so that the latter succeed the former in every Point of Ground, and in every Motion forwards of their Body; by this last Method of Motion a good *Horse* will pass over four Miles in length in about seven Minutes, which I believe is as much as any of the Race of *Quadrupedes* can do; but is not to compare with what is reported of the Flight of some *Birds*. If we believe the Accounts given us of the *Carrier Pidgeon*, which we are told will fly twenty Miles in fifteen Minutes, and may easily be try'd; at that rate such a *Bird* flies eighty Miles an Hour, which, in a natural Day, or four and twenty Hours, would amount to 1920 Miles; which continued Flight, during that Length of Time, I believe is in the Capacity of a *Bird* to perform; considering the Passage of some *Birds*, which, if they go to any part of this World when they leave us, it must be at least two thousand Miles, *i. e.* either into *Tartary*, or some part of *Africa*; for I do not find that they are ever observ'd in *Europe* when they have left this Country. And I am of Opinion, that few *Birds* can fly much longer than four and twenty Hours without resting, or at most two Days without eating: But we are sure that Animals of the four-footed Kind cannot even maintain the height of their Swiftnes a quarter of an Hour: So that it appears that *Birds* have a far greater Share of Strength and Spirit than *Quadrupedes*.

There are five sorts of *Hair* observable in the Cloathing of *Quadrupedes*, viz. the short *Hair* upon the *Hides* of *Horses*, *Asses*, and *Kine*; the long *Hair* in the *Mans* and *Tails* of *Horses*; the *Wool* of *Sheep*; the *Bristles* of *Hogs*; and the *Hairs* in the *Beards* of *Cats*, *Tygers*, &c. These have every one of them a kind of *Vegetative* Growth, and are renew'd Yearly, unless the Creature they grow upon is distemper'd. I suppose them to be of the Nature of *Bulbous-rooted Plants*, which when the *Leaves* of them decay, a new framed *Root* from the same *Plant* supplies their Loss with fresh *Leaves* the next Season. In the *Hedghog* the *Spines* or *Thorns* which cover its Body are *analogous* to the *Hairs* upon the *Skin* of other *Quadrupedes*; but I suppose may remain for many Years, whereas the others are *Annual*; and so likewise I imagine the *Quills* of the *Porcupine* to fill the place of *Hairs* in other *Beasts*, tho' they are of a much harder Substance; and all these Coverings, as they proceed from the Bodies of different *Quadrupedes*, commonly vary in their Colours, but are never so beautiful as the *Feathers* of *Birds*. Among *Beasts* we never observe any *Hairs* of a *Scarlet* Colour, nor is *Blue* or *Green* natural to them, and even *Yellow* is very sparingly given to this Tribe; while, on the other hand, *Birds* are adorn'd with *Feathers* of all Colours. Their Note, and Beauty of their Plumage, lead the *Ear* and the *Eye* into the greatest Admiration; but when we consider them farther, they are but Toys in comparison of *Quadrupedes*, which, tho' they are not thus gayly attir'd, do that Service to the World, that it is worth while even for *MEN* to attend upon them, and serve them in some Respects, and even bear the Expence of their Living.

The *Lion*, *Panther*, *Tiger*, *Leopard*, and *Cats* of all Kinds, have sharp *Talons*, somewhat resembling those in the *Eagle* and *Hawk* Kind; and for the better preserving them from wearing or blunting their Points, Nature has provided Cases for them in the *Paws* of those Creatures they relate to. What I call the
Claw-

Claw-footed, are *Dogs* of all Kinds, whose *Claws* are of a *Horny* Substance, somewhat like the former, but are not guarded. *Hoofs* of *Horses*, *Affes* and *Mules* are *single*, and are not of so hard a Substance as the former. The *double-hoof'd* or *Cloven-footed* Tribe have their *Feet* cas'd with Substances of a *Horny* Nature; of which Class is the *Wild Boar*, *Stag*, *Fallow-deer*, *Sheep*, *Goat*, and *Kine*. In one Kind indeed of the *Hog* Race, which I have observed at the late Earl of *Stamford's*, the *Hoofs* are not cloven or divided; but it is remarkable, that if a *Sow* of that Breed is Coupled with a *Boar* of the *Cloven-footed* Kind, some of the *Pigs* will be *Cloven-footed*, and others *single-hoof'd*.

Of the *Horn'd* Race, the *Buck* is one of those Creatures which sheds his *Horns* every Year, and is not longer than three Months renewing them again, which is a kind of Vegetation equal to the quickest growing *Plant*. The *Stag* and some other sorts of *Deer* are subject to shedding and renewing their *Horns* annually, like the former; and in the larger Kinds are sometimes of that Extent, that in a direct Line they measure from Tip to Tip above a Yard: they are so solid and hard when they are fully perfected, and of so large a Size, that one would wonder how possibly the Body of the *Animal*, that produces them, could furnish Juices enough to fill and explain them to so great a Bulk in so short a time. I am not unsensible that there are particular Names and Terms of Art for every respective Part of these branched *Horns* of *Deer*; but I confess my self at present ignorant of them, that Knowledge being of little Use either to my Reader or my self, in a Work of this kind. It is remarkable in the *Deer* Kind, that the *Females* have no *Horns*, which I suppose is common with those Creatures whose *Males* shed their *Horns* every Year.

The next Kind of *Horned Animal* is the *Gazella*, or *Antelope*, whose *Horns* are erect, and twisting like a Screw; these are not branch'd, nor do I find they ever shed. After these the

Goat has his *Horns* twisted, and the Points bending towards his Back, but not both of them alike. The next is the *Sheep*, whose *Horns*, like the former, are twisted, and regularly curl'd. It is observable, that the *Horns* of these last Kinds are always larger in the *Males* than in the *Females*; but it is otherwise among *Kine*, whose *Horns* are smooth, and of large Extent; in these the *Females* have *Horns* much larger and longer than the *Males*, unless they have been castrated; in such *Oxen* I have measur'd a Yard between the extream Points of the *Horns*.

The Food of four-footed Beasts is either *Flesh*, *Fowl*, *Herb*, *Grain*, or *Fish*. Such as feed up *Flesh* are Beasts of Prey, and of the most Savage Kind, as *Lions*, *Tigers*, &c. whose *Talons* are chiefly designed for Catching and Tearing their Prey to pieces. The *Otter* and *Beaver* feed chiefly upon *Fish*, which their *Amphibious* Nature and Structure of Parts enables them to catch. The *Hog* Kind eats indifferently of *Flesh*, *Fish*, *Fowl*, *Roots*, *Fruits*, *Herbs* and *Grain*. The *Deer* Kind, *Sheep*, *Goats*, *Kine*, *Horses*, and such generally as are of the *Hoof'd* Race, feed upon *Grass*, *Hay*, or *Corn*. And it may be remark'd, that such as use the latter kind of Diet are the most tameable and familiar with Mankind; but such as feed upon raw *Flesh* are positive in their Ferocity, unless they are familiarized when they are very young, and kept low in their Diet.

The *Quadrupedes* of Use and Service to Mankind are the *Elephant*, *Camel*, *Horse*, *Kine* of all sorts, *Sheep*, *Dogs*, *Cats*, and some others. Where *Elephants* are naturally placed, they are of great Use after they are tamed, in transporting of great Burdens, and carrying Men to Battle, where their Conduct and Strength is of extraordinary Service, if we may believe those Authors who have mention'd them. We have now one of them in *London*, who is so observant of the Orders of his Keeper, that one may reasonably place him amongst the most tameable of the four-footed *Animals*; and even allow him a Share of natural Sense, at least

least equal, if not superior, to any of the four-footed Race.

The *Elephant*, now in Town, is about twenty eight Months old; and about fourteen Hands and a half in height; his *Tusks* or (rather) *Horns* are now beginning to appear, or bud in the upper Jaw, which gives me Occasion to suppose them rather *Horns* than *Teeth*; and again, considering what vast Numbers of them are annually brought into *Europe*, I am almost perswaded they shed like the *Horns* of *Deer*. It is remarkable in this Creature, that the Joints in the *hind Legs* are disposed for kneeling, as well as those in the *fore Legs*, which is contrary to other *Animals*. Its Method of Drinking, is by sucking its *Trunk* full of Liquor, and squirting it down its Throat. But we may see a large Description of this Creature of a greater Age, and in more perfect State, with the Anatomy of it, in the *Phil. Trans.* N^o 326, and 327, by Dr. *Blair*, F. R. S.

The *Camel* and *Dromedary* we have likewise had in *England*; they are *Beasts* of Burden, and very swift; and it is reported of them that they will live many Days without Water, even in the hottest Climates. Some Creatures indeed I know will live without any Water at all, as the *Hare* and *Coney*, which I have kept above three Years, and they have never had any.

There are many Kinds of *Horses* remarkably distinguish'd for their different Uses. In *Northamptonshire*, and some of the *Midland* Counties, are such as are fit for the Coach, and drawing of other Carriages. In *Flanders*, *Denmark*, and some of the Northern Countries, we likewise find *Horses* of Draught, differing in their Frame and Turn of Body, and varying in their degree of Strength, as the Countries they were bred up in differ from one another. In the North Parts of *Britain*, and some Places in *Wales*, are bred the best *Horses* for the Saddle. The first State of their Life being among the Mountains, enables them to endure hard Labour. Besides these, the *Spanish Horses* are counted the most famous for the Parade; and the *Turkish* and
Barb

Barb Kinds, for Beauty, are reckoned to exceed most *Horses* in the World.

Next to these the *Kine* Race is accounted the most useful. In many Parts of *England* *Oxen* are of great Service in Ploughing, drawing of Carriages, and for many other Works in Husbandry; besides the Service of their *Flesh*, after they are worn out by Labour, and the excellent Uses of their *Hides* and *Tallow*, and even their *Horns* for making necessary Utensils; while the *Cows* afford us *Milk*, *Cheese* and *Butter*; not only enough for our own Use, but even to supply the Neighbouring Countries. Nor are *Sheep* less useful to Mankind, their *Annual* Produce of *Wool* serving to employ as many People as their *Flesh* can maintain in some Places of *England*. Their *Milk* is likewise made use of, and turns to good Account; to which we might add the Service of their *Skins*, which afford us *Leather*, *Parchment*, and *Vellum*.

Of the *Dog* Kind we have many different Sorts, such as *Greyhounds*, *Blood-hounds*, *Beagles*, and others, for Hunting and taking of Game: And again, our *Spaniels*, either for Land or Water, *Setting-Dogs*, *Pointers*, &c. serve to find out Sport for their Masters; and some of them are even useful for Draught and Carriage. In *Holland* and *Flanders* especially, they are commonly employ'd in the Harnes for drawing small Waggon and other Carriages. To these we may add such other Kinds of *Dogs* as are used for the Guard of Houses, among which the *English Bull-Dog* is the highest in Esteem, for his exceeding Fierceness and Resolution.

The Voice of all these Creatures is as various as the Structure of their Mouths and Throats is different. We may discover each Kind of them by their Note or Tone, as well as distinguish one *Bird* from another by the Difference of their Song. The Parts which relate to this kind of Speech among them, are like so many Instruments of Musick producing different kinds of Tones.

We

We might likewise mention how aptly all Kinds of *Dogs* are disposed to receive Instruction, and how observant they are to the Dictates of their Master.

The *Apes* and *Monkeys* of several Kinds are naturally disposed to imitate the Actions of Men; but indeed the Figure and Disposition of their Parts agree much more with those in Mankind, than the Parts of any other Creature; and I believe some sorts of them might be rendered useful, if convenient Care was taken to instruct them when they were young. One sort indeed, which comes from the *East Indies*, is very vicious; and I remember has more than once attempted to force a Servant of the House where he was kept: But I am informed that some of the larger Kinds have been so well instructed, that they would do many little Offices that their Master directed them to do. It is no difficult Matter to be satisfied how much these Creatures are capable of Instruction, since there are so many of them daily brought to *England*. They are great Lovers of strong Liquors, and frequently are inebriated with them. They love *Tobacco*, and smoak abundantly if they can get at it. Nor is the *Man-Tiger* less guilty of these Vices when he has Opportunity; his lower Parts are like those of a *Monkey*, but his Head is more like that of the *Hog*, and is a Creature very ready to imitate the Actions of Men. The *Females* of these have periodical Visits, like *Females* of the Human Race. I conclude, that as the different Tone of Voices proceeds from the different Structures of the *Organs* of Sound in *Animals*, so the Difference of their Capacity and Understanding proceeds from the various Frames of those Parts which furnish the *Brain* with nourishing Juices.

All *Quadrupedes* generate by coupling one with another; but are differently impower'd by Nature to increase more or less their several Species. Some of the larger Kind, such as the *Elephant*, *Horse*, *Kine*, and *Deer*, seldom bring more than one or two at a time; whereas the smaller Kinds of *Animals*, and such as are subject to be destroy'd, encrease more plentifully. The *Hog*
Kind

Kind will sometimes bring seventeen or eighteen young ones at a Birth, and the *Dog* Race about ten, *Cats* and *Rabits* about five a-piece, *Rats* and *Mice* about eight or nine a-piece, *Squirrels* three or four, *Hares* two or three, and *Sheep* sometimes as many. And with regard to the Generation of these Creatures, the natural Time of Coupling is in the Spring Season, somewhat later than *Birds*; but by means of forcing Diet, some of them may be brought to couple even in the Depth of Winter; 'tis by that Means that we have now young *Lambs* at almost every Season of the Year; and some Creatures, as well in this as in the *Bird* Kind, couple and bring forth young ones seven or eight times in a Year, as the *Rabit* for Example, and some others. We may also remark, that every *Quadrupede* has not the same Length of Time appointed for its Growth to its compleat State: The large Kinds, such as *Horses* and *Kine*, are hardly full grown in three Years, *Hares* and *Rabits* about eight Months, *Cats* and *Dogs* twelve Months, which perhaps may depend, in great measure, upon the Length of Time they are respectively maintain'd in the Womb of their *Dams*; but every Kind of *Bird* grows to its full Bigness in a few Months; and some Kinds of *Fowls* are about a Year accomplishing their Growth; which Difference I suppose happens as the Difference of Time is appointed, more or less, for the Incubation and Hatching of their *Eggs*, some setting only three Weeks, and others a Month, before the young ones are excluded, or can make their way through their *Egg-shells*. And I believe the Length of Life allotted for several *Animals* is various, as the Time of their being included in the Bodies of their *Dams* is more or less. There are some of the larger Kind of Creatures which carry their young ones many Months, as the *Mare*, *Cow*, and the *Elephant*, as it is said, longer than any other Creature; but *Rabits* do not go above a Month, *Cats* about twice as long: and I believe, was it possible to know the Nature of all Creatures, we might find, according to their Proportion

portion and different Habit of Body, a continued Progression, with regard to their Size, Growth and Length of Life. For in *Plants*, which I have been more conversant with, I observe that kind of Progression; and even it is to be remark'd, that the several *Seeds* which they spring from, have as different degrees of Time appointed for their hatching or sprouting in the Earth; and likewise such as lie longest under Ground without shooting, are commonly more lasting than those which begin to shoot in a few Days; and we may observe something of the same kind in *Insects*. The Distance of Time between the laying and the hatching of the *Eggs* laid by some sorts, is very different from what we observe in others; and the Time of Life in the *Caterpillar* of one Kind, is not the same that we observe in another, no more than the number of Days is the same in all, for bringing the several *Flies* out of their *Crysalises*.

But it remains for me to say something more particular of the Generation of four-footed *Animals*, as it is the next relating, and in some Cases is nearly agreeing with that of Mankind. Were we to look back upon what I have already mentioned concerning the Generation of *Fowls*, *Fish*, and *Plants*, and even of some Creatures of the four-footed Tribe which are cover'd with *Scales*, it will appear that the *Eggs* of the *Females* are absolutely necessary for the Production of them; and I suppose that the fecundating *Liquor* or *Dust* of the *Male* is as necessary to make them prolific. In this Race of *Animals* every *Female* has its *Ovaries*, or *Egg-Nests*, which, without the Intromission of the prolific Juice of the *Male*, remains sterile or barren: It therefore appears that the *Male Liquor* is necessary to impregnate the *Eggs* contained in those *Ovaries*, either by some *Animalcules* of it passing into the *Eggs* there contained; or else that the *Animalcules* wound those *Eggs*, and so occasion them to grow over, and enclose them in such a manner, as the Blisters upon *Oaken Leaves* swell and enclose the little *Insects*, whose *Eggs* are laid

in the wounded Parts by their Originals: But this Case has admitted of vast Dispute, either because some of the Disputants could not imagine how the *Animalcula* could get into the *Ovaries*; or else that some suppose there is not Passage sufficient for the impregnated *Egg* to fall into the *Matrix*; but these I suppose draw their Judgments from the State of those Parts when the *Animal* is dead, which, in my Opinion, must then be very different from what they were when the *Animal* was alive; for then these as well as all other Parts of the Body have a Power of contracting or dilating themselves; and a Passage, which at one time is hardly capable of admitting the Point of a Pin, may probably be capable of being dilated so much as to give room for the Exclusion of a full grown *Foetus*; and certainly it would be very unreasonable to suppose these Parts are in the same Posture during Coition, that they are at another time when the Body is not disposed for it; at which time it is highly probable Nature has given those Parts a different Action and Power of extending themselves. I could say much more of this, if the Case had not already been so much perplex'd; and I am loth to trust too far to my own Opinion, in an Affair of so much Difficulty. However, that I may not leave my Reader altogether unsatisfied in a Point of so great Concern, I shall entertain him for a while with what has past by way of Letter concerning this Subject, between Dr. *Geoffroy* of the Royal Academy of *Paris*, and Dr. *Andry* of the same Place.

Dr. *Geoffroy* tells us, that such as support the System of *Eggs* in all Creatures, suppose the little *Animal* to be included in the *Egg*; but this they cannot demonstrate till after Fecundation: Also they suppose the little *Germ*s of *Plants* to be enclosed in the *Seeds*; but these Rudiments of the *Plant* in the *Seeds* cannot be discovered till after Impregnation by the *Farina* issuing from the *Male* Parts. On the contrary, if we examine the *Eggs* of *Animals* before they have been rendered fecund by the *Male*, we cannot observe

observe the least Principle of the *Animal*. In the *Eggs* which the *Hens* lay without a *Cock*, although they appear fair, and as large as the others, yet nevertheless we can only discern in them an empty *Cicatricula*, in which the little Body is not residing. Those who have had the Management of *Silk-Worms* may remark, that when a *Moth* has laid its *Eggs* without the Assistance of the *Male*, those *Eggs* are transparent and void of that little black Point which we discover in such *Eggs* as are fecundated, and is the beginning of the little *Worm* or *Caterpillar*, 'tis therefore we are not to expect any good from those transparent and barren *Eggs*. It happens sometimes that we meet with these transparent *Eggs* among those that are impregnated, even tho' they were all laid by the same *Moth*, which must proceed from some particular Cause in the Coupling of the *Male* with the *Female*.

We may likewise observe the same thing in the *Grains* and *Seeds* of *Plants*; we often meet with *Seeds* that are without the *Germe* or *Seed-bud*, and are consequently barren, and these are found even in the middle of the fairest Fruits. If we observe likewise the *Seeds* of any *Plant* at the first opening of the *Flower*, we find them clear and transparent; but if we examine them some time after the *Flower* is decayed, that is to say, after their Fecundation, those *Seeds* become *Opaque*, by means of a little Body enclosed, which is properly the *Germe* or *Seed-bud*.

The *Ovarists* suppose that these *Germs* were originally in the *Seeds*, and that they are now only grown bigger than they were at first; but this is a bare Supposition; for since we cannot discover this Point by the best *Microscopes*, either in *Eggs* or *Seeds*, before they have been fecundated, and that it may be easily discover'd after Coition, it is more natural to believe that those *Germs* were not subsisting in the *Eggs* or *Seeds* before they were impregnated, but from the very Instant of their Fecundation. To convince us of what I advance, we are only to consider what happens in the Time of Fecundation among *Animals*.

Among those *Fish* which do not couple, the generative *Liquor* of the *Male* is only scattered upon the *Eggs* which have been laid by the *Female*, while they flit in the *Water*. In other *Animals*, where Things cannot be observed in the same manner, we know only that the *Liquor* of the *Male* is conveyed into the Cavity of the *Matrix*, even as far as the *Phalopian Tubes*, where it is often found in such *Animals* as have been opened a little while after Coition; and we may presume that it even passes into the *Ovaries*, and sprinkles some of the *Eggs* of the *Female*. It appears then that Impregnation proceeds from an Effusion of the *Male Liquor* upon the *Egg*; from whence we may naturally conclude, that the Effect produced by this *Liquor* upon the *Eggs*, is chiefly to convey the little *Germ* or *Animalcule*; which is found in the *Egg* after that time, and the rather, because the *Animalcule* may always be observed in that fecundating *Liquor*.

And we have yet more reason to believe that these *Animalcules*, which abound in the *Male Liquor*, are the Principles of Generation, or the Beginning of *Man*, and other *Animals*, as we find them always constant in the *Liquors* which are included in the *Spermatick Vessels* of every *Animal*, varying according to their different Species; but we sometimes find them wanting in those *Liquors*, either through extreme Age, or when Distempers have rendered them barren.

The System of the Generation of *Animals* being thus stated, we shall reason only upon constant Facts; whereas the *Ovarists* suppose that the Rudiments of the *Animal* are always in the *Egg*, although they cannot see them, and moreover, that there is a fecundating Spirit in the Generative *Liquor* of the *Male*; but these are uncertain Suppositions; for according to them this *Seminal Spirit* must be exceeding *Subtile* and *Volatile*: And nevertheless, among the *Aquatick Animals*, this Spirit, however *Volatile* it is, is neither enervated nor dissipated by the *Waters* with which this *Liquor* mixes it self; but this is altogether impossible.

possible. The greatest part of *Fish* do not couple, but the *Females* cast their *Eggs* or *Spawn*, and the *Males* which follow them scatter their *Milt* over the *Eggs*. Now before the Waters have extended this *Liquor* over all the *Spawn*, it must necessarily happen that the fecundating Spirit is dissipated. The Difficulty of Impregnation is still more considerable in *Oysters* and other *Shell-Fish*, which are fastned to Rocks, or the Bottom of the Sea, without having little or any Motion. The *Milt* of the *Males* is carried backwards and forwards at the Will of the Waters, and at last by chance is brought to the *Eggs* of the *Females*, and renders them fecund. What will then become of this *Seminal Spirit*, when it is tossed about from place to place? If Generation was brought about by its Means, it would surely have time enough to exhale, and then the *Eggs* of *Oysters* and other such like *Shell-Fish* could not be impregnated by it.

But we shall avoid these two Suppositions in our System, and endeavour to produce more solid Arguments for the Generation of *Animals* than the *Ovarists* have done. And first let us examine if the Generation of *Plants* does not carry along with it some Analogy to that in *Animals*.

Till the *Flower* begins to fade, we cannot perceive any *Body* or *Germe* of a *Plant* in the *Embrios* of the *Seeds*, or *Seminal Vessels*; nor can we discern any Change in those *Embrios* till the *Dust* of the *Stamina* is fallen.

This *Dust* of the *Stamina* is necessary for Fecundation; for in all *Plants* where these *Stamina* appear, if we cut them off before they open, the *Fruits* will not come to Maturity; or if they should happen to ripen, they are without *Germs*, and are consequently barren.

The Necessity of this *Dust* of the *Stamina* for the Growth of the *Seeds*, for the bringing of them to Maturity, and for making them pregnant, is confirm'd by the Observations of all *Botanists* upon the *Palm* or *Date Tree*.

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This sort of *Plant* bears its *Stamina* upon a different *Tree* from that which bears the *Fruit*; so that one is stiled *Male*, and the other *Female*. *Theophrastus*, *Prosper Alpinus*, and all the *Botanists* agree, that if a *Female Tree* has not a *Male* in its Neighbourhood it does not bring forth *Fruit*, or if it bears any, they rarely come to Maturity; they are ill tasted, and without *Kernels*, and consequently without *Germs*: But to bring this *Fruit* to Perfection, and make it fit to eat, Care is always taken either to plant a *Male Palm-Tree* in the Neighbourhood, or to cut *Branches* of the *Male Palm-Tree*, garnish'd with *Stamina*, and tie them to the *Branches* of the *Female Palm-Tree*, and then it produces good *Fruit*. This Observation was confirmed to *Monfieur Tournesort* in 1697, by *Hadgi Mustapha Aga*, a curious Man, *Ambassador* from *Tripoli* to the King of *France*.

There is one *Objection* which may be made against what we have mentioned concerning the *Palm-Trees*; *Monfieur Tournesort* tells us that he has seen a *Female Plant* of *Hops* produce *Seed* in the King's Garden, where there was never a *Male Plant*. But we may suppose that the *Farina* or *Male Dust* was brought to the *Female Plant* by the Wind from some other Place; as in the Case mentioned by *Jovianus Pontanus*, *Preceptor* to *Alphonso* King of *Naples*, who tells us, that in his Time there were two *Palm-Trees*, one of them *Male*, cultivated at *Brindes*, and the other *Female*, growing in the Wood of *Ottiranto*; that this last was several Years without bearing any *Fruit*, till at length having out-grown and rais'd its Head above the other *Trees* of the Forest, it could perceive, says the Poet, the *Male Palm-Tree* at *Brindes*, although they were several Leagues asunder, for then it began to bear *Fruit* in abundance; and there is no Reason to doubt but it then begun to bear *Fruit*, because it then received the *Dust* of the *Stamina* upon its *Branches*, which was conveyed by the Wind from the *Male Palm*. We may explain by this, in a natural manner, that *Fecundity*, which so much embarrass'd
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the antient Physicians, and which they attributed to a Sympathy, or Love among *Trees*. *English'd* thus from the Author's Original.

*A Female Palm for many Years had stood,
The Virgin Glory of Ottranto's Wood.
No vernal Bloom with Flowers her Branches dress'd;
No Clusters her unfruitful Boughs depress'd.
Till distant far, in Brindisi's fair Vale
Aspiring, she beheld the noble Male.
Tho' distant, yet the genial Power she feels;
Thro' every Vein the fertile Humour trills.
The pregnant Branches now their Blossoms yield,
And every Bough with ripening Fruit is fill'd.*

It may be objected, that I have no sufficient Proof, that every Grain of this *Dust* is a *Plantula* or *Germ*, since the *Microscope* shews us that each Grain is in the Form of a little *Globe* or *Egg*, either smooth, or set with Points, sometimes bor'd through the Middle, or of some other Form or Manner. I agree that it is difficult to distinguish in every one of these little Grains of *Dust* the Rudiment of a *Plant*, because it is wrapt up in its self, and perhaps may be covered with a *Membrane*, or at least cloathed with some *Resinous* Matter; perhaps Time may discover some way of unfolding the little *Germ*, or freeing it of its Covering; but allowing this to be only a bare Supposition, we may agree that it is not altogether unreasonable, since it is not till after the Intromission of these little Bodies into the *Pistillum* or *Uterus* of the *Flower*, that we can perceive any *Opacity* in the *Seminal Vessels* or *Embrio's* of the *Seeds*, which in their Growth discovers to us that they are in effect the *Germes* of *Plants*.

In short, what confirms this *Hypothesis* is its Uniformity with what we have discovered relating to the Generation of all living Bodies.

After

After having establish'd the Proofs of our *Hypothesis*, I am to answer the Objections which may be made against it.

First, It may be objected that an *Insect* cannot quit its Nature, as an *Insect*, to take upon it that of a *perfect Animal*.

It is an antient Error to make the Distinction of *Perfect* and *Imperfect Animals*. Our Eyes do not discover the same Parts that are in some *Animals*, in *Worms*, *Butterflies*, *Flies*, *Bees*, and other *Insects*; so that some have thought such Parts were wanting. We see them take their Birth in *Mud*, *Dungbills*, *putrified Flesh*, and *rotted Herbs*; which has made some believe that these little Bodies had no other Origin than a *Fortuitous Asses- blage of putrifying Parts of Matter*. They have even believed that larger *Animals*, such as *Frogs*, *Wild Ducks*, &c. had the like Beginning, without reflecting that those *Animals* were constant in their Frame and Parts, which are always produced alike; and that it is impossible that Chance could produce an Arrangement of Parts always uniform and constant. We are obliged to the learned Mr. *Redi*, for having first set this Matter to rights, by giving us Proof that the Generation of *Insects* comes from *Males* and *Females*, agreeable to the System of *Eggs*, as it is among all other *Animals*. Many learned Physicians, and particularly Monsieur *Swammerdam*, have begun the *Anatomy of Insects*; and we are obliged to that great Man for having shewn us that those little *Animals* had Parts agreeable to ours, or at least did the same Functions; but as that Work was left unfinished, Monsieur *Duverney* has taken it up, and continues it with great Accuracy and Judgment, tracing those little Creatures from the Beginning to the End; and far from representing *Insects* as *Imperfect Animals*, he discovers so much Art and Contrivance in their Structure, that they seem to be even more *Perfect* than the most considerable *Animals*. In *Caterpillars*, and such *Worms* as change into *Butterflies*, and in such *Reptiles* as take *Wing*, it is surprising to observe the Changes which happen throughout the

the interior Structure of their little Bodies. An infinite Number of Parts, which were folded up, explain and open themselves at the End of a certain time; some become absolutely useless, dry up, and fall off; and others are alter'd beyond our Knowledge. Nothing can be more admirable than the Tracing of all these Changes. A *Frog* is a *Fish* in its Beginning, named *Tadpole*; it has a great Head, the Mouth of a *Fish*, the Finns and Tail like *Fishes*; it respire by the *Gills*, which are *Lungs* peculiar to *Fishes*; some time afterward its *Tail* and *Finns* drop off, and its *Feet* appear, which are as well adapted to Walking as Swimming; the Fore-part of its *Head*, or rather its *Mask*, falls off, with its *Gills*; in the mean while, the *Lungs*, which resemble those in terrestrial *Animals*, unfold and dilate themselves, and become expanded and very visible, from almost invisible Parts that they were before. May not we look upon this as an extraordinary Perfection, and even more than Man himself can boast of, that Gift of Power in tasting Life successively in different States and in different Elements?

These Considerations may undeceive those who are prejudiced in their Opinions, that a Creature in the Rank of *Insects* cannot become a *perfect Animal*, especially if they reflect that for the most part the State of *Worms* or *Caterpillars* is only a State of Passage to bring them to another Form; so that those *Worms* which are commonly ingender'd in *putrify'd Flesh*, change into *Flies*; likewise several great *Worms*, which remain sometime under Ground, change into *Beetles*; *Silk-Worms*, and *Caterpillars*, become *Moths* and *Butterflies*; and I think the *Earth-Worm* is the only Species which does not suffer a *Metamorphosis*.

This being premised, we may regard the Form of the *Worm* or *Animalcule* in the Generative *Liquor* of *Animals*, as an Instance of the Certainty of a future *Metamorphosis*.

It may be objected in the second place, that I attribute an imaginary Instinct to the little *Animal* or *Animalcule*, to make it

rise into its Cell. I confess the Difficulty of explaining so great a Mystery as that of Generation, without meeting a thousand Obstructions and Questions, which cannot be resolved without great Pains and Trouble; but when an Effect is so evident that it meets with no formal Opposition, it does not seem reasonable to contest it; such is the Difficulty in Dispute. Instinct in this place is not the Question; for I have not attributed it to the little *Animal* as a Means whereby it is convey'd into its Cell. I know too well, that in Physical Disputes we must make use of Mechanick Laws, and I shall endeavour to give such as are most probable.

The prodigious Multitude of *Animalcules* swimming in this Liquor, which disposes it self to overflow the *Egg* that is prepared to be impregnated, makes it almost impossible, that one of them at least should not reach the little opening of the *Cicatricula*; and that from this prodigious Multitude there is not above one which can find place; for the *Cicatricula* is not capable of containing any more; but if by chance it is big enough to admit of two, we shall find two *Fœtus* under the same Covering, or else a monstrous double *Fœtus* joined together by some part of the Body. This is one Proof of the Authority of this System.

Thirdly, It may be said that we carry our Thoughts too far, in supposing these little *Animalcules* to be the Principles or first Points from whence Mankind is derived, and that they may have been appointed to swim in the *Seminal Liquor* for other Uses: as for Example: They may be supposed to agitate that *Liquor*, and to facilitate the *Exhalation* of the *Spirits*.

Besides what I have already observed of those who suppose a powerful *Spirit* in this *Liquor*, it seems much more natural to me to draw this Consequence (*i. e.*) That the *Animalcules* which are found in such vast Numbers floating in a *Liquor* so necessary for Generation, are themselves the immediate Cause of Generation, and not to believe that they are only remote Instruments
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of it; because we do not discover any nearer Cause. After this the Use which is assigned them is far from necessary, and there is no Likelihood that there is any Probability in it; for every thing that is *Liquid* has in its self a motive Power, without having Occasion of such feeble Assistance, as that which it might receive from *Animals* moving in it; for is it not reasonable to suppose that *Fish* were created in the Seas, or *Birds* were made to move in the Air, to prevent the Stagnation of those *Liquids*? the one is not more plausible than the other.

Fourthly, It is said that Conception, by means of the *Animalcule*, is disagreeable to the System of the unfolding of the Vessels and Parts. But wherein is this System of Unfolding more attack'd in this *Hypothesis*, than in the common Sentiment of the *Eggs*? If we admit that *Adam* had in himself all the *Animalcules*, as it were, incased one within the other; do not also the *Ovarists* suppose in the same manner that all their *Eggs* were enclosed one in another, and contained in the Body of *Eve*? They cannot therefore make any Objections upon that Account, since we may as easily oppose their Opinion of the *Eggs*. But to defend both these Opinions against those who are too much embarrass'd by the System of Unfolding of Parts, let them join with me, and consider how Nature acts in her Course, and they will see how the System of the Unfolding of Parts is incumbred, but at the same time must agree to the Truth of it. But let us now examine what Mr. *Dodart* says upon the *Fecundity* or *Encrease* of *Plants*, in his Memoirs, inserted in those of the *Royal Academy of Sciences for the Year 1700*. It is wonderful, says he, that the *Fecundity* or *Encrease* of *Plants* has been so little observed by the World, especially since they are so commonly exposed to the Eyes of all People; not only the *Natural Encrease* of *Plants* of their own accord, but also their *Artificial Encrease*, produced by Cutting or Amputation of their several Parts. This *Artificial Encrease* he proves to be no more than *Natural*; for, as he ob-

erves, the Art of a Gardener cannot give to *Plants* what they had not in themselves, his Art only assists them to unfold and explain those Parts which they were originally possess'd of. Here follows an Example of the Encrease and Multiplication of a *Tree* by the *Seed* only, which is the last Term and Object of all the Productions of a *Tree*.

He says that the *Branches* of the *Elm* are so many *Banches* of *Seeds* or *Grains* extremely press'd one against the other; and having taken an *Elm* of six Inches Diameter, and twenty Foot high in *Stem*, which was about twelve Years old, he cut off a *Branch* of eight Foot long; and neglecting the *Seeds* which had been shaken off by the repeated Blows of the Axe, and the Fall of the *Branch*, he yet found remaining on it 16450 *Seeds*.

We may suppose that an *Elm* of six Inches Diameter must carry more than ten *Branches* eight Foot long; but suppose ten only, then these ten *Banches* may reasonably produce, according to the above Account, 164500 *Seeds*. All the *Banches* which are less than eight Foot long, taken together, make a Surface more than double the Surface of the ten *Banches* of eight Foot; but supposing them only double, because perhaps these lesser *Banches* are not so prolifick as the others, then all the *Banches* together produce 329000 *Seeds*.

An *Elm* may be supposed to live an hundred Years; and it is not reasonable to suppose that the mean State of its Fertility should be at the Age of twelve Years; we may then justly reckon, that in an indifferent bearing Year it will produce 329000, or may well enough suppose 330000 *Seeds*, which are little enough. Again, we must multiply this 330000 by the hundred Years Life of the *Elm*, which makes 33000000 of *Seeds*, which an *Elm* produces in its whole Life-time, taking every thing at the lowest rate, and these 33000000 came all from one single *Seed*.

But this is only the natural Production of the *Tree*, which hath not yet produced all that it contains.

If the *Tree* had been headed it would have sprouted afresh from the Trunk, and at least produced as many *Branches* as it had before in its natural State; and these new Shoots would not require more than the Space of six Lines, or thereabouts, in height of the Extremity of the headed Trunk to shoot from.

At whatever Place, or whatever Height the *Tree* had been headed, it would have always regenerated with equal Vigour; which is constant, as appears by the Example of *Dwarf Trees*, which are continually kept cut almost down to the Ground.

From hence we learn, that all the Trunk of a *Tree*, from the Earth, to the first germinating of the collateral *Branches*, is fill'd with Principles or little *Embrios* of *Branches*, which cannot possibly appear all at the same time; we conceive them to be parted by little circular Rings of six Lines in height, each of which in particular is ready to produce *Branches* as soon as an Amputation is made exactly above it.

All these invisible *Branches* (although they are hidden) are no less existing than those which appear to us; and if they were once manifest they would produce an equal Number of *Seeds*, which consequently they must already contain in little.

Now were we to follow the Example proposed, there is included in this *Elm* as many times 33000000 of *Seeds*, as there are Spaces of six Lines contain'd in the twenty Foot height of the *Stem*, that is to say, fifteen thousand eight hundred and forty Millions of *Seeds*; and that this *Tree* contains actually in its self wherewithal to multiply and reproduce such a prodigious Quantity of *Plants* as would surpass all intelligible Numbers.

What will those say to these Observations, who are afraid of over-burdening the System of unfolding of Parts? Will they not be forced to acknowledge that their Ideas are too narrow for the infinite Foresight of the Creator in the Propagation of living Beings? But it is permitted at present, that our Reason even penetrates

trates beyond its own Power, where the Senses have carried us; and where they begin to abandon us, they will plainly discover, that whatever their Senses have shewn them, is nothing in comparison of that which may hereafter be found out; for if we only suppose that each Grain of a *Tree* contains in it self a second *Tree*, which again encloses the same Number of *Seeds*; and that we can never discover a Grain which contains more *Trees*, nor a *Tree* which contains more or fewer *Seeds* than the preceding *Tree*; then consequently there is a Geometrical Progression of Growth, whose first Term is one; the second 1584000000; the third the Square of 1584000000; the fourth its Cube, and so on, *ad infinitum*; so that our Reason and Imagination would in some sort be lost, and swallowed up in the immense Calculation.

This prodigious Chain of Numbers strikes Terror in the Spirits of those who are not used to push their Meditations to any great Length; but those who are used to the Study of Physick and Mathematicks, know very well that they cannot go far without meeting some kind of Infinity, as if the Author of Nature had been careful that his principal Character shou'd reside in every thing.

If then we agree with the System of unfolding of Parts in *Plants*, which I think there is no reason to doubt of, we may as easily admit the same in *Animals*, and it will be so much the more demonstrable, as this System is the most simple of all others; for if we once suppose that all Things were created at one time, as it is seemingly intimated in that Passage of *Ecclesiasticus* 18. ver. 1. *Deus creavit omnia simul*, we need not torment our selves to find out how organiz'd Bodies may form themselves, which is no more than the unfolding and explaining of their Parts one after another; where, on the contrary, 'twill always be found as difficult to explain their *Fortuitous Formation*, as it will be to demonstrate that *Gold, Silver, Copper, Steel, and Enamel,*

mel, being put into a Crucible, the Parts of each Matter would arrange themselves in such a manner, as to form a Clock or Watch.

Fifthly, It is objected, that the *Animalcule* which begins to discover it self in the *Egg* after Conception, is not a *Worm*: But this will be of Use to me in my Proofs.

I answer to that, That if we could open the *Cicatricula* of the *Egg* immediately after Conception, (that is to say, as soon as the *Worm* is entred into that part) we might discover that little *Animal* yet under the Form of a *Worm*; but as it begins to grow bigger almost as soon as it receives a new Nourishment in the *Egg*, and as new Parts begin at the same time to unfold themselves in it, it is not strange to find it then alter from the Form of a *Worm*; and we may observe the different States of its Passage from that Form, to that of the *Animal* which is to be produced.

With regard to the Observations of the *Foetus*, whether it be formed in the *Ovaria*, or in other Parts of the *Matrix*, a very little while after Conception, those Observations do not destroy my *Hypothesis*. All that can be said is, that the little *Animalcules*, which are the Principles of Mankind, lose the Figure of *Worms* a little after they are entred the *Eggs*, and begin to take upon them the human Form: And as to that Observation of our learned Critick, that Nature gives the most *perfect Animals* a longer time of Ripening, or coming to their last State, although it is not a general Rule, yet nevertheless it happens to be true enough in Mankind.

Among the Observations of the *Foetus* inserted in the Memoirs of the Academy Royal, Mr. *Dodart*, in the Year 1701, has given us one of the most remarkable, of an *Embrio* of one and twenty Days; it was then but seven Lines in length; and it was difficult to distinguish its Parts; the *Head* and the *Trunk* of the Body only could be discerned; the *Thighs* and *Arms* were not yet unfolded;

folded; and the *Head* was one third of the whole Length. Can we then say that this *Embrio* had the perfect Figure of Mankind, or was entirely formed? and was it not in this State more like to a *Worm*, which it was originally, than to the Form of Man? For we may suppose that the *Head* of the little *Worm* was become the *Head* of the *Fœtus*, and that the rest of the Body had been hidden in that part, which made the *Tail* of the same *Worm*; but here I may say that the *Worm* is not yet perfectly of the Form of Mankind (to speak like our Author) at the End of nine Months, when he should come into the World; for we may say that he is not in his perfect State till he is twenty Years old, which is about the time when an human Body has acquired all its Proportions; which agrees with the Account of our Critick, who will not be surpris'd, that a *Worm* may be changed into a perfect *Man* in so long a Space of Time.

Sixthly, In the next place they attack the *System of Planes*, and object, that the Disposition of certain *Pistils*, which lengthen themselves beyond the *Apices*, cannot therefore admit of or receive the prolifick *Dust*.

I agree that some *Pistils* are much longer than the *Apices*, and have their *Orifices* a good Distance beyond them; but this only happens in reversed *Flowers*, such as the *Crown Imperial*, &c. where this Situation of the *Pistillum* favours Fecundation; for in such *Flowers* the *Dust* cannot fall from the *Capsules* of the *Apices*, without falling upon the *Pistils*, which, in some Subjects, are garnished with little *Hairs*, the better to retain the prolifick *Dust*; besides, most of them are endued with a *Glutinous* or *Viscous* Matter. In the *Tulip*, and some other *Flowers*, the *Pistillum* does not begin to raise it self above the *Apices*, till they are full ripe, and have scattered their *Dust*.

I agree that it is not sufficient to prove only that the prolifick *Dust* of the *Apices* may fall upon the *Pistils* of the *Flowers*; we must conduct it even into the very *Cells* of the *Seeds*: And I
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own that it is very difficult to comprehend how this *Dust* can get there; but because we find a Difficulty in any thing, are we therefore to conclude it is impossible? and especially when we may observe so much Preparation as we see in *Plants* towards the perfecting of the prolifick *Dust* in the *Apices*; as also how it is scattered when it is full ripe, at a certain time, when the *Pistils* are ready to receive it: May we not remark as much Difficulty in the Generation of *Animals*? when we find that the Entrance of the *Infundibulum* or *Vagina* of the *Matrix* in *Birds* is very distant from the *Ovaries*. One can hardly imagine how the *Eggs*, when they detach themselves from the *Ovaries*, seek out the Overtures of the *Vagina*, although there is no doubt but they do. So all the Garniture of *Flowers* may persuade us of the Necessity of the prolifick *Dust* for impregnating the *Seeds*; and the Proofs which I have already given may convince us of it. A few Observations, which Time may produce, will set this Matter in a clearer Light.

Seventhly, I am told that the *Blossoms* of an *Apricock Tree*, which were robb'd of the *Apices* by *Vermin*, produced good *Fruit*. But are they assured that all the *Apices* were entirely eaten, or whether they were destroyed before they had scattered abroad some of their *Dust*?

Eighthly, We are not to suppose that the Wind can be an Intermitter in this kind of Fecundation.

But is it more difficult to suppose that the Air is an Intermitter in the Fecundation of *Plants*, than to make the Element of Water an Intermitter in the Propagation of *Fish*, and chiefly of *Oysters* and other *Animals*, which lie *immovable* at the Bottom of the Sea?

Ninthly, They add, that if the little *Grains* of the prolifick *Dust* were so many *Plants*, they would produce as many *Plants* as there were *Grains* falling upon the Earth. And why then don't

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they

they raise the same Difficulty in the *Liquor* design'd for the Propagation of *Animals*? for, in short, if the little *Animal* or *Animalcule* does not meet with a convenient Nourishment in the Earth or Water to make it grow, and can only find what is necessary for its Support in the *Egg of the Female*; neither can the little *Germ* of the *Plant* meet with a proper Nourishment in the Earth to unfold its Parts, but only finds it in the *Embrio* of the *Seed*.

If my Reader will examine carefully, without Prejudice, the several Opinions upon the Generation of *Plants* and *Animals*, and weigh well the Proofs of one and the other, and observe the Difficulties which are to be met with in all these *Hypotheses*, I doubt not but he will agree with ours, as it is the most general, and has less Suppositions than the others; and after all, I desire him to observe that I lay this down only as an *Hypothesis*, in which appears more Probability of Truth than any I have yet seen upon this Subject.

There are two Things yet remarkable in Generation after the *Eggs* are impregnated. In some *Animals* the *Eggs* are excluded from the Body of the *Females*, to be afterwards incubated and set upon, till the Creature is so far perfected as to break its way through the *Shell*, as in the Case of *Birds* and *Fowls*, which are therefore called *Oviparous*: but the Case of *Quadrupedes* is different; the *Fœtus* is not excluded from their Bodies, till it has taken that Form or Figure which it maintains to the End of its Life: such *Animals* are termed *Viviparous*. One might make yet several remarkable Distinctions among those created Bodies which are *Oviparous*. The *Eggs* of *Birds* hatch at once into Bodies properly formed, agreeing with the Figures of their own Race. The *Spawn* or *Eggs* of *Frogs* have several different Changes before they gain their compleat Figure. The *Eggs* of *Butterflies* and *Moths* hatch at first into *Caterpillars*, and from this
Shape

Shape change into a *Chrysalis*, and from that again into the *Fly*. The *Seed* or *Eggs* of *Plants* hatch at once into a *Plant*; tho' indeed we may observe in some of them a considerable Difference between the *Seed Leaves*, and those which they are adorn'd with when they shoot out their *Stalks* and *Branches*. The *Ear Leaves*, or those next the *Root*, as I have already hinted, doing the same Office to the *Virgin Plant*, as the *Breasts* or *Dugs* of the Mother *Animals* do to their Young, *i. e.* to furnish them with their first Nourishment, and support them till they can find a suitable Food in the Earth; and this is so certain, that if we take away the *Ear Leaves* of a *Plant*, soon after it has made its first Shoot from the *Seed*, the *Plant* will die in a short time. The *Eggs* or *Spawn* of *Fish* hatch and become *Fish* at once; but in some of this Race (I am told) the *Eggs* or *Spawn* are not impregnated till after they are excluded from the Bodies of the *Females*.

It is observ'd by some great Men, that the *Animalcules* in the *Seminal Liquor* will live several Days after the Death of their *Male* Parent; and even some have gone so far, as to affirm, that these *Animalcules* will remain alive in the *Matrix* of the *Female* two or three Months after the *Liquor* has been lodged there, altho' they had not the Advantage of the proper *Nidus* or *Egg-Nest* to afford them any help, and then conclude that those Parts may be impregnated by such *Animalcules* two or three Months after Copulation, which (as they say) is the Reason that some *Females* are longer between the time of Coupling with the *Male*, and the bringing forth their Young, than others; so that, according to their System, some of the Human Race may bring forth eleven or twelve Months after they have been with a *Male*.

To confirm the System of Generation by the *Animalcules* in the *Male Liquor*, we may observe, that in such *Animals* as are not yet arriv'd at their highest Perfection, the *Male Liquor* in

them is wanting of *Animalcules*. If we examine the *Testicules* of small *Chicken*, or any young *Bird* or *Fowl*, soon after hatching, or any *Animal* newly brought into the World, the *Male Liquor* has not any *Animalcules* in it, no more than can be found in the *Seminal Vessels* of an extream old Man, or any Creature that has been worn by Distempers; but we never fail to find them in vast Numbers in such Bodies as are full grown, and in a vigorous State of Health. But I shall conclude this Account of Generation, with observing only, that the *Egg* of the *Female*, before Impregnation, seems to possess a Degree of Growth or Life, somewhat like that in *Minerals*; when the same *Egg* is impregnated, it then possesses a kind of *Vegetative* Growth; and takes upon it the *Animal* Life and Growth as soon as it quickens, at which time it only begins to enjoy the Power of *Sensation*.

We come now to observe such of the four-footed Race as are *Amphibious*, or live as well upon the Land as in the Waters: Such is the *Hypopotamus*, or *River-Horse*, which is found about the River *Nile*, which Creature is as big as a large *Bull*. There is now one of them well preserved at the Physick Garden at *Leyden*. After this the *Otter* and *Beaver* may be observed, as *Animals* which inhabit Pools, Ponds, and Rivers of little resort; whose Prey is chiefly upon *Fish*. And next these the *Seal* or *Sea-Calf* may well enough be placed, as it much more relates to *Quadrupedes* than the *Fish* kind: It is *Viviparous*, and thinly clothed with *Hair*, and likewise suckles its Young; but its *Tail* and Finn-like *Feet* declare it to inhabit the Waters, for the most part, being rather contriv'd for swimming than for walking or moving upon the Land.

Having now consider'd the principal Parts of *Quadrupedes*, and given some Account of their Uses, I am led naturally to treat of such Creatures with four *Legs* as are partly *Animal*, partly *Insectal*, such as *Frogs* and *Toads*.

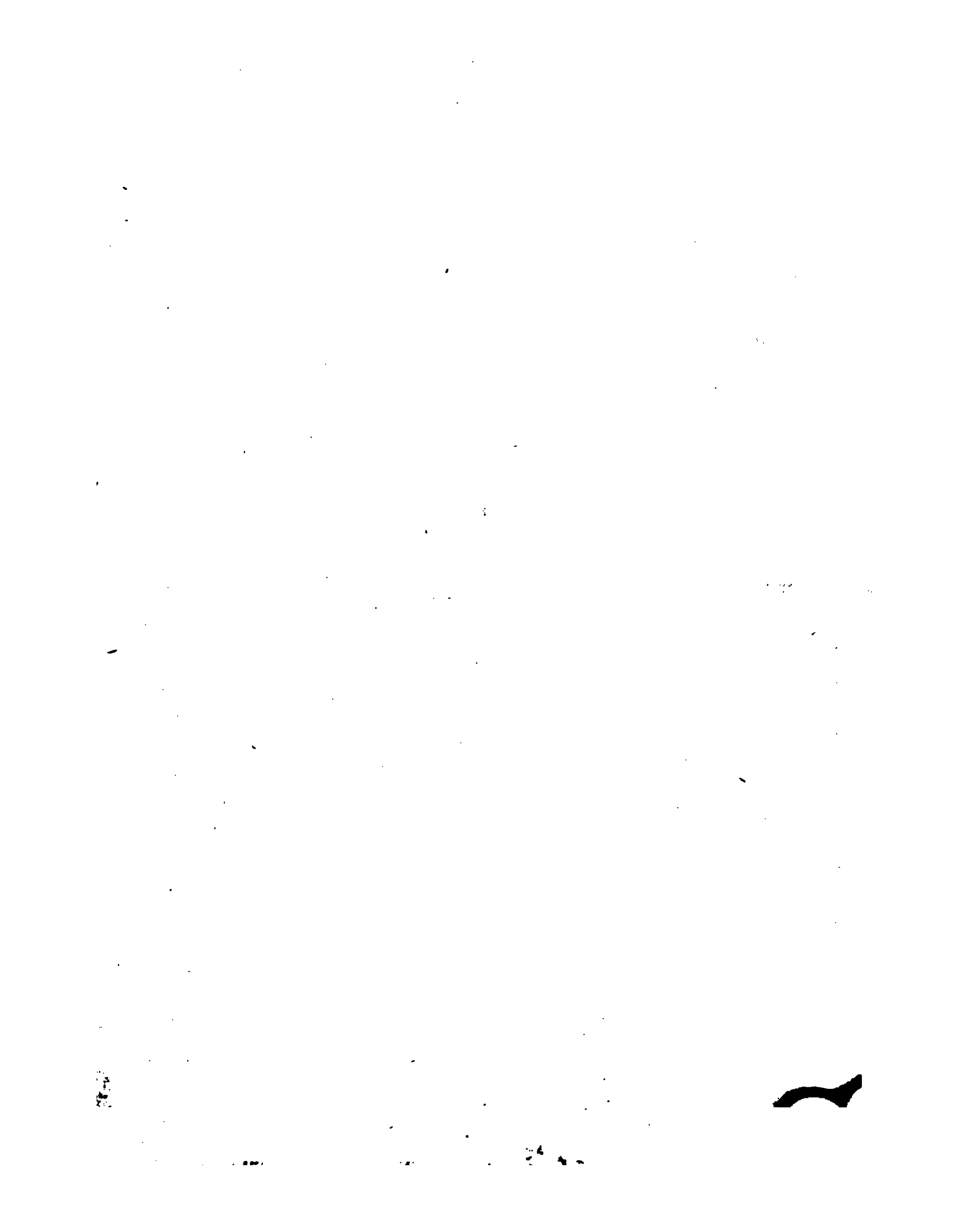


Fig. I.



Fig. II.



Fig. III.



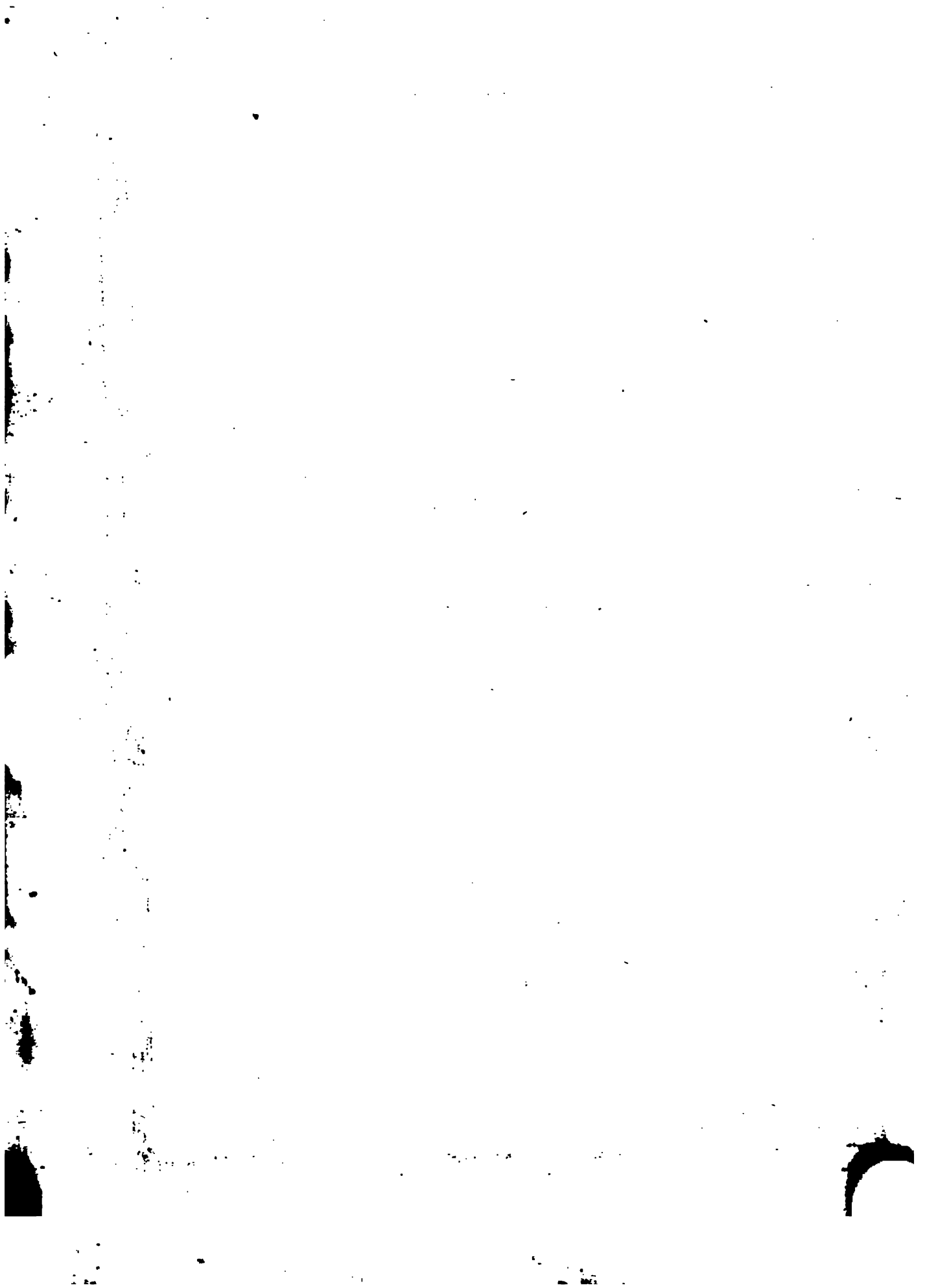


Fig. I



Fig. II



Fig. III.



I suppose it may be wonder'd at, that hitherto I have not mention'd Mankind, who is so remarkable a Creature, and Lord of all the rest; I confess, was I to have placed him where the Parts of his Body would most agree with those of the created Bodies mention'd in this Treatise, I must have set him in the middle of this Chapter; but I suppose my Reader will excuse me, if I shew him so much regard, that I rather speak of him in the summing up of my Scale, than let him be encompass'd with wild Beasts.

Explanation of the Plates relating to this Chapter.

P L A T E XIV.

Fig. I. *The Head and Legs of a Cat, setting forth the Disposition of those Parts in most Beasts of Prey.*

Fig. II. *The Head and Legs of a Mouse, shewing the Difference between the Claw-footed and the Talon-footed Beasts, as also the Disposition of the Joints to help them in their Motion.*

Fig. III. *The Head and Legs of a Horse, in which we may observe the Strength and Manner of its Jointing, and the whole Hoofs of a Horny Substance, disposed as well for its Defence as for hard Labour.*

P L A T E XV.

Fig. I. *The Man-Tiger; from Africa.*

Fig. II. *A Monkey of an extraordinary Kind; from Mr. Randal's in Channel-Row.*

Fig. III. *The Head and Legs of a Spaniel, being a Continuation of the Claw-footed Kind.*

P L A T E

P L A T E XVI.

Fig. I. *The Head and Legs of a Hog, being one of those Cloven-footed Animals, without Horns.*

Fig. II. *The Head and Legs of a Buck, or a Cloven-footed Animal, of the Annual Horn'd Race.*

Fig. III. *The Head and Legs of a Stag, or the largest Kind of the Cloven-footed Annual Horn'd Race.*

P L A T E XVII.

Fig. I. *The Elephant, brought from Fort St. George in the East Indies, whose Tusks are not yet cut or budded. As the Tusks of this Creature always grow in the Upper-Jaw, I suppose them rather Horns than Teeth.*

Fig. II. *The Head and Legs of a Goat, or one of that Race with irregular twisted Horns which are Perennial.*

Fig. III. *The Head and Legs of a Sheep, being one of the Race which produces curl'd twisted Horns.*

Fig. IV. *The Head and Legs of a Bull, serving as an Example of the smooth Horn'd Tribe, whose Horns are Perennial.*



C H A P.



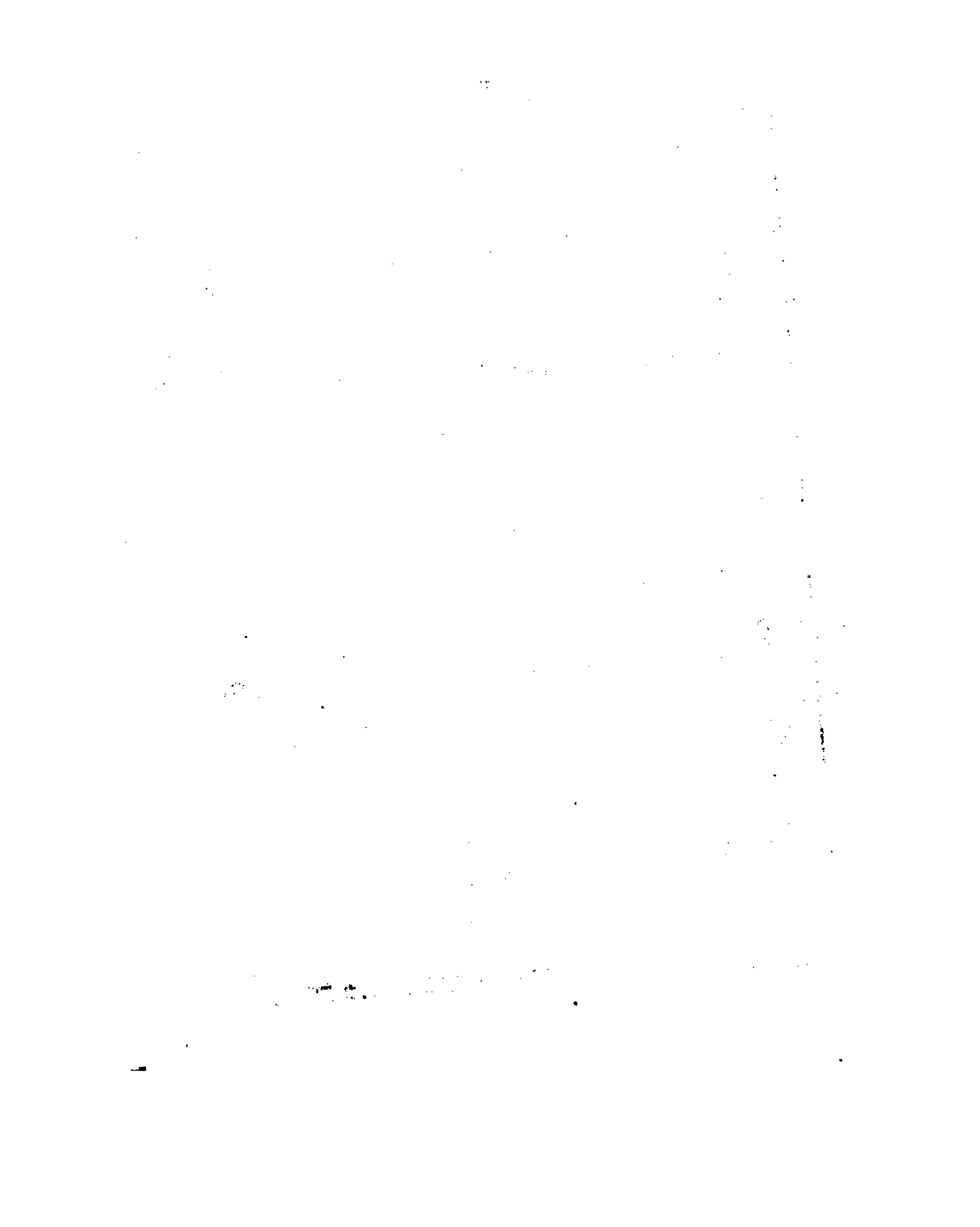


Fig. I.

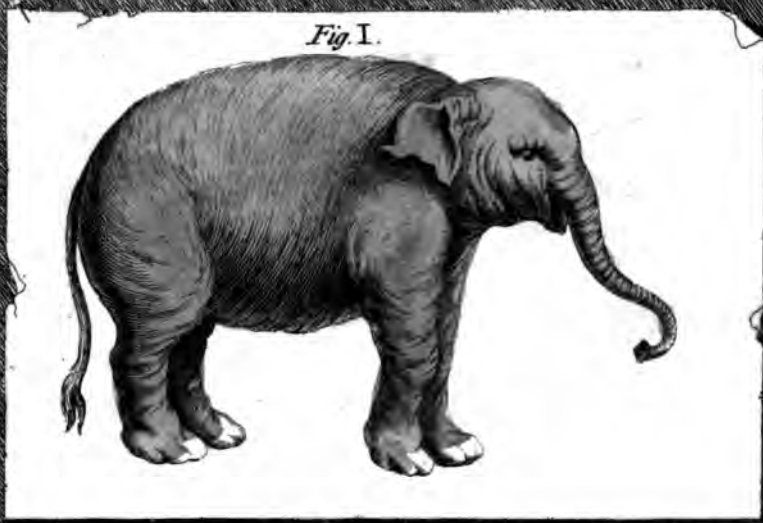


Fig. II.



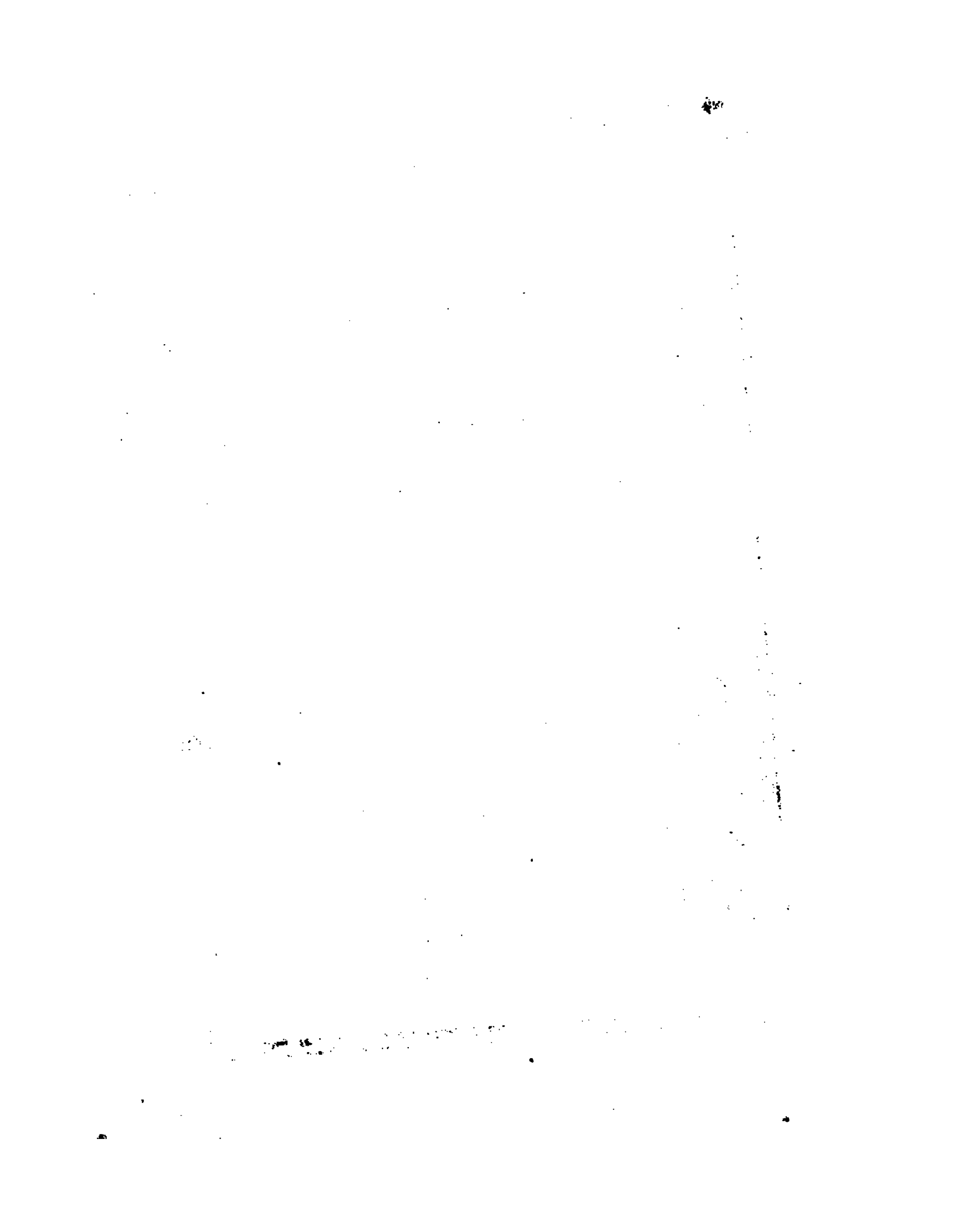
Fig. III.



Fig. IV.



J. Colclough sculp.



C H A P. X.

Of FROGS, TOADS, and such Creatures as are partly Animal and partly Insectal.

THE Creatures which are the Subject of this Chapter, are in some respects like the *Animals* treated of in the preceding Pages, and in other things are analogous to *Insects*: They agree with the former in the number of their *Legs*, and the Method of their Coupling, only that in these the *Male* and *Female* are join'd for three Days, and the *Quadrupedes* already mention'd are not so long in that Act. Their fleshy Parts are like those in *Animals* of the four-footed Kind; but the many different Changes they have between the *Spawn* and the *perfect Frog*, is as remarkable as those in the *Insect* Race. Again, the *Frogs* sleep, or are laid up in the Winter, as are the longer-lived *Insects*: And their different Degrees of Life, within and without the Waters, make them somewhat analogous to *Gnats*, which live their first Stage of Life in the Waters, and the Remainder of their time in another Element.

The Difference between the *Frogs* and *Toads* in *England* is very remarkable, tho' some will hardly allow any, which I suppose proceeds from their want of Observation. They will have it that *Toads* are no more than *Male Frogs*, or that all *Frogs* that have black Backs are those which we ought to call *Toads*; but I hope to set them right in the following Accounts of both.

The *Skin* of our *English Frogs* is smooth, their Motion nimble and agile: one sort has the *Skin* of the *Back* of a dark Colour, and the other is yellow, mark'd with Specks here and there. The *Skin* of the *Toad* is rough and knotted, and its Motion is heavy, dull, and crawling: the *hind Feet* of the *Frog* are webb'd
like

like those of a *Goose*; and *Frog Spawn* is large as *Pease*, and is brought forth in a clump. The *Feet* of the *Toad* are not webb'd, and its *Spawn* is small, and chain'd together. *Toads* will live in damp shady Places without ever entring the Waters; but *Frogs* cannot live without them. The Voice of the *Toad* is much coarser than that of the *Frog*, and its Method of Life in many things different. A *Toad* will live a long time in the Air-Pump, after the Air is exhausted; but a *Frog* will die in less than half the time. We have Instances of *Toads* that have been taken out alive from the middle of large Blocks of hard Stone. And I was once Eye-witness of a *Toad* which was saw'd out of the Center or Heart of the Trunk of a large *Oak*; but I have never yet heard of any *Frog* that was thus enclosed. It is reported that an angry *Toad* will piss a sort of venomous Liquor, which is injurious to any living Creature it touches, but especially to Mankind. I had once one of them, which spouted some of this *Liquor* in my Eye, but I received no Damage from it, perhaps because I immediately wash'd it with fair Water at a Pump; but we do not find that *Frogs* ever produce a *Liquor* of this kind. 'Tis common in *France*, and some other Countries in *Europe*, to eat the hinder Legs of *Frogs* as a great Dainty; but I have not yet heard of any that have been bold enough among the *Europeans* to feed upon *Toads*, unless some few Mountebanks, who have done it to shew the Excellency of their Antidotes. I have often heard that the People of *China* sell *Toads* in the Markets, of a very large Size, and hold them to be great Dainties; but I suppose they are rather *Frogs* than *Toads*, and have only been thought to be of the latter Kind, for want of Knowledge enough of the material Differences which we find in one and the other. Upon the *Alps* there is a kind of *Toad* about four times larger than our *English Toad*. And I have seen in the Cabinets of Mr. *Seba* and Dr. *Ruysh* of *Amsterdam*, many Kinds of them well preserv'd, and great Variety of *Frogs* with long *Tails*, curl'd *Ears*,

Ears, and their *Backs* mark'd with various Figures. In the first of these Cabinets there is a remarkable Set of *Frogs*, which, from the Form of the common *Frog*, differ in the Frame of their Parts gradually, till the last is of the Figure of a *Fish*, which Gradation of *Frogs* may serve to adorn the next Work I shall write of this Nature. It will be sufficient for me at present to give my Reader an Account of their Generation, and of their gradual Alterations from the *Spawn*, till they become *perfect Frogs*, as it was observed by that accurate Anatomist, Dr. *Douglas*, F. R. S. to whom I am likewise obliged for the following Account, viz.

Of the curious Structure and Constitution of the Genital Parts in a Female Frog, full of Eggs.

OF all the constituent Parts of this despicable, loathsome, little Animal, there's none more artfully contrived, nor so curiously framed, as those that serve for propagating the *Species* in both Sexes, but especially in the *Female*; and from the great Analogy and Likeness that's between these in this little *Animal*, and those in Women, we may draw a most convincing Argument to strengthen and enforce their Opinion, who maintain the System of the *Eggs*.

Two *Ovaria's*, two *Oviductus's*, and two *Uterus's*, are the Parts to be described.

The *Ovaria* are two large *vesicular Bags*, formed of a thick glandulous *Membrane*, with a *Cavity* within very apparent, if you distend them with Wind.

Each *Ovarium* is placed about the middle of the *Abdomen*, laterally on each side the *Spine*, being fastned by *Blood-Vessels* and *fibrous Connexions* to the *Mesentery*, about the upper part of each *Kidney*.

Their Bigness varies according to the Number and Magnitude of the *Eggs* they contain; for just after they have drop'd off they look flacid, being contracted into a narrow Compass, feel soft and slimy, and appear of a yellowish Colour, having a

number of little black Specks or Points here and there intermix'd; but when the *Eggs* are come to their Maturity and full Ripeness they are very large, and look of a black Colour spotted with white, very much distending the *Belly*.

The *Tubes* or *Oviducts* are two long *Channels* or *Pipes* lying on the Sides of the *Belly*, between the *Lungs* and the *Uteri*. In their natural Situation they are rolled up and fastned together by a *Membrane*, as by a *Mesentery*, making several anfractuous *Gyri*, or winding Circumvolutions, not unlike the small Guts in little *Birds*.

These, as well as the *Ovaria's*, differ in Bigness and Colour, according to the Seasons of the Year, and different times of Gestation; for just after all the *Ovula* are pass'd, they are slender, and very small, of a yellowish Colour: However, if they be thrown into the Water, they swell and become something bigger: But just before the *Ovula* are loosened, they are as big as a *Goose-quill*, of a whitish Colour; and if they are then thrown into Water, they will, in the Space of one Night, swell six times bigger, and in a little time after they will dissolve into a kind of Mucilage or Gelly. The Inside of these *Tubes* are covered with a thick, slimy, glutinous Matter, which besmears the *Ovula* in their Passage, and afterwards serves for a *Nidus*, if not for Nourishment also, to the little *Animals* or *Tadpoles*, all whose perfect *Lineaments* are wrapped up and contained in these *Ovula*, as it were, in Miniature; so that when all that roapy, viscid gluten, separated there by the *Glands*, is rubbed off, they must needs lessen in their Bulk.

The Beginning of each *Tube* is upon the *Septum Transversum*, just under the *Lobes* of the *Lungs* near the *Heart*; it opens by a pretty large *Orifice*, and its Substance, for about half an Inch, is membranous, with some *Striae* or *Ridges* appearing upon it.

The *Uterus* is made up of a very thin and transparent *Membrane*, being divided into two distinct *Cavities* by a *Septum*, and each of them opens by a particular *Orifice* into the *Rectum*

Intestinum, which passing over this *Bag*, braces it down, and makes it bulge out on each side.

When the *Ovula* are come to their full Maturity, they are detached from the *Ovarium*, and being loosened, they fall into the *Cavity* of the *Abdomen*, where they float about for some time, till by the Motion of the *Sterum* and abdominal *Muscles*, being much assisted by the constant and long Compression of the *Male Frog*, (which, according to the Observation of the curious *Swammerdame*, rides upon the *Back* of the *Female* for forty Days compleat, closely embracing, and clasping round its Body with its *Fore-legs* under hers, joining its *Claws* upon the *Sterum*) being received into its gaping *Orifice*, the same Motion does forward its Progression to the *Uterus*; and it's not improbable, but the *Tube* it self may have something of a vermicular Motion, which may be of use in propelling the same; after they have been sometime in the *Uterus* they are discharged, *statis temporibus per Annum*; the *Male* being ready, at that very Instant, to besprinkle them with his *Semen*, in order to impregnate and render them fruitful.

We find in the common *Female Frog*, that the *Ovaries* spread themselves almost over its whole *Back*, and even reach within a very little of the *Head*, which I believe is common to all of the *Frog* kind, altho' they do not always produce their Young after the same manner. The curious *Surinam Frog*, which Madam *Mariana* of *Amsterdam* has published in her *History of Surinam Insects*, brings its young ones perfectly fram'd into the World; after they are hatch'd in certain Cells, within the *Skin* of the *Back*. Sir *Hans Sloane* has one of these Creatures in his Cabinet; and we may find others of the same in the Collections of Mr. *Vincent* at *Harlem*, Dr. *Ruysh* and Mr. *Seba* of *Amsterdam*, and at the Physick Garden in the same City, in which Cabinets of Rarities I have observed this *Frog* in three different States; first, the *Pores* of the *Back Skin* were all closed, excepting three

or four, which began to be forced open by the *Eggs* lodged in Cells below them. The second had all the *Pores* in the *Skin* of the *Back* so much opened, that I could plainly discern the Points of the *Eggs* within them; and the third had young ones perfectly formed in all those Cells in the *Back*, as it appears in the Figure of the twenty second Plate. I chuse rather to rank it with *Frogs*, as it is Web-footed, and an Inhabitant of the Waters, than place it with the *Toad* Race.

From what we have here said, it appears that *Frogs* and *Toads* partake of many Qualities observable in *Insects*, though not in every respect; but as they agree with them in some Particulars, I shall next consider those Insectal Bodies, which may be stiled irregular *Insects*.

Explanation of the Figures relating to this Chapter.

P L A T E XX. A.

In this Figure I. A. the Parts of Generation in a Female English Frog are delineated, being first taken out of the Body, and then expanded.

A: A: *The Tuba Uterina or Oviduct separated from its Connections, and drawn out to its full length.*

1. *Its upper Orifice.*
2. *Its opening into the Uterus.*
3. *Some of the Ovula sticking in its Cavity.*
- B. *The Oviduct of the other Side.*
4. *Part of the membranous Mesentery left on.*
5. *The Circumvolutions and Windings of the Tube.*

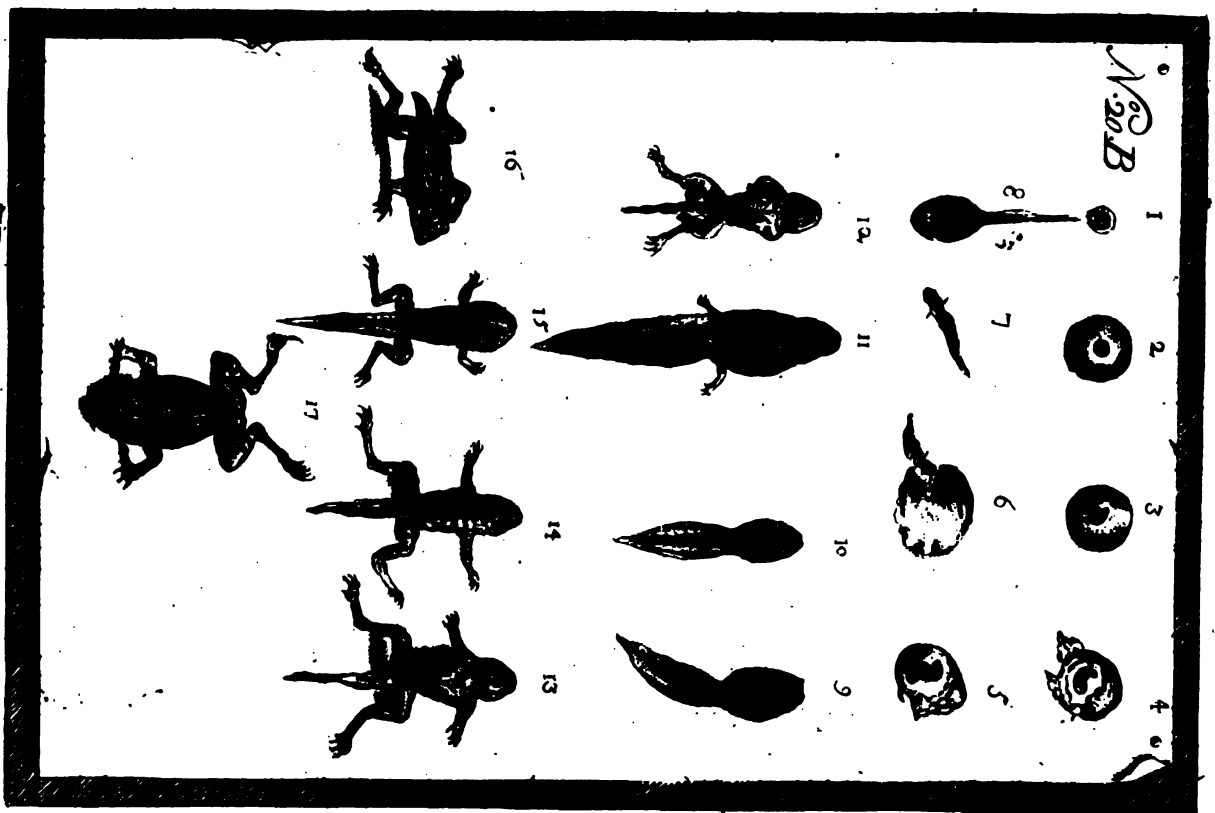
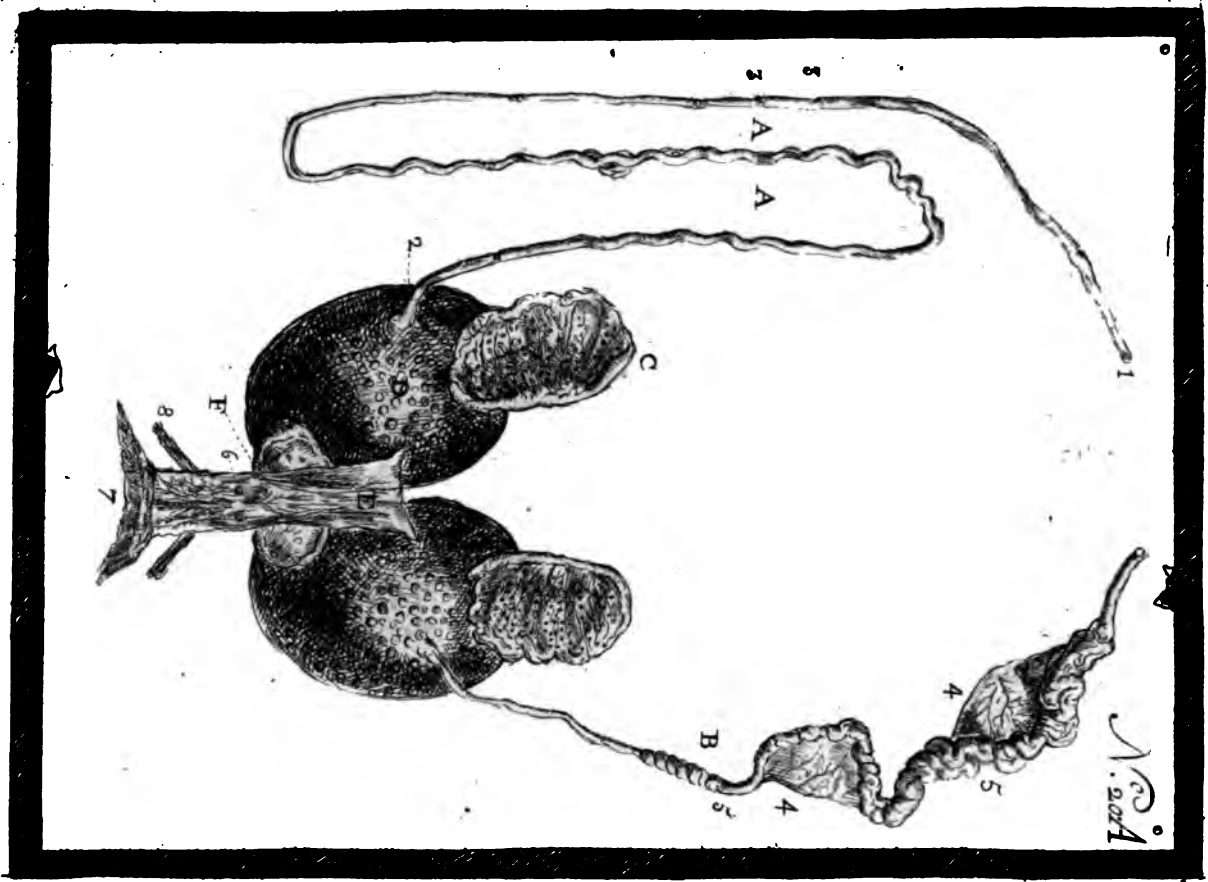
C. *The empty Ovarium.*

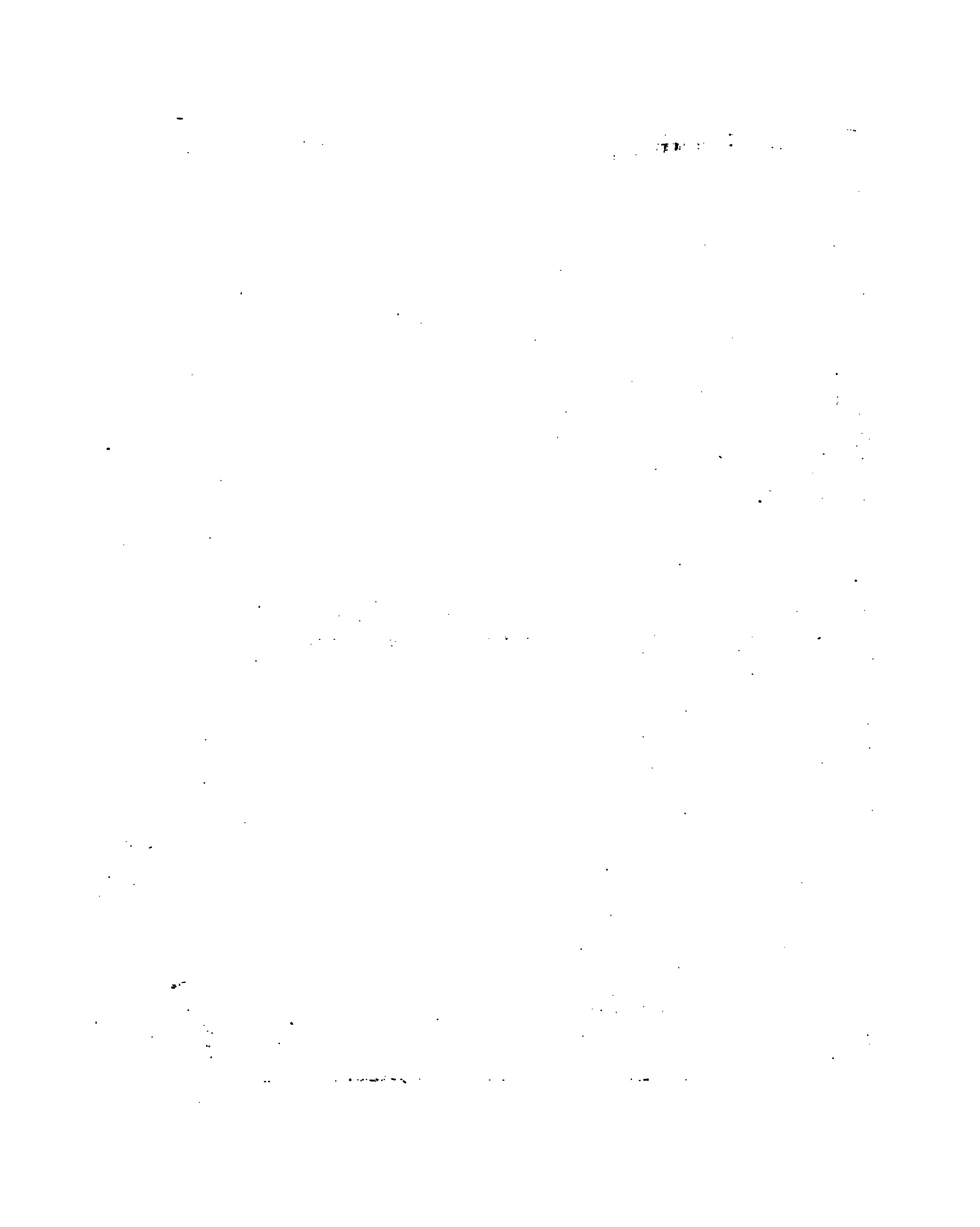
D. *The Uterus distended with Eggs or Spawn, appearing of a blackish Colour at the Sides, but whiter in the Middle.*

E. *The Intestinum Rectum cut open, and turned back on the Sides of the Uteri.*

6. *The small Orifice or Opening, by which the Ovula pass from the Uterus, tempore partûs.*

7. *The*





7. *The Sphincter Ani.*
8. *The Levator of the same.*
9. *The Vesica Urinaria divided and laid back.*

P L A T E XX. B.

In this Plate are represented, in Seventeen Figures, drawn from the Life, the slow and gradual Epigenesis Ranarum; that is, all the remarkable Changes, and the several Gradations that are observed in the Growth of a Frog, from the Ovum, or Spawn, to a compleat and perfect Animal.

N^o 1. *Exhibits an Ovum just spawned, and taken out from the Heap, or as it appears when it drops from the Uterus in a Cluster, having a round black Speck, or punctum nigricans, in the Middle, which is the first Rudiments of the Tadpole: The Outside of this Spot is of a whitish Colour.*

N^o 2. *This Number shews the Ovum, after it has lain some Days in Water, surrounded with its gluten, or a viscid, glewy Substance, commonly called Sperma Ranarum, or Frogs Spawn.*

N^o 3. *Here the black Speck has changed its round Figure into a longish one, being curved, and smaller at one end than the other.*

N^o 4. *In this the Gyrimus, or little Animal is grown bigger, and the Pellicula, or thin Membrane, that contains the viscid Substance, appears ragged and tore, as if Cobwebs hung to it.*

N^o 5. *The glutinous Humour, that in the preceding Figure was smooth and even, appears in this, to be hollow like a stoned Raisin.*

N^o 6. *This Number shews the Gyrimus (which now has put on the Shape of a Vermiculus, or little Worm, called properly a Tadpole, and by our Country People a Bull-head) sticking by its Mouth to the glutinous, alimentary Substance. After the Vermiculus had undergone this Change, I first observed it to move its Tail, and become a living Animal.*

N^o 7. *Here we have exhibited the little Tadpole detached and freed from the viscid Matter, that not only served for its Nourishment, being received in at its Mouth, for it had nothing analogous to*
the

the Vasa Umbilicalia, to convey it that way, but also for a Bed to lye on while weak and tender: here are likewise observable, a Head, Body and Tail, with two little sharp Points near its Head.

N^o 8. *This Figure represents our Gyrinus much bigger, with a thicker Head and Body, and a long narrow Tail; and being touched, was able to move it self in the Water very nimbly and quick, like a small Eel; and from this frequent whirling round in the Water, this little Creature is named as above.*

N^o 9. *In this Tadpole you may perceive some of the Windings and Circumvolutions of the Guts, through the thin transparent Skin, and other Integuments of the Belly.*

N^o 10. *By this Figure the same Animal is represented in a different View, in which it appears to be less than the former.*

N^o 11. *Here we may with Pleasure observe the two hinder Legs sensibly budding out: the Tail, which, like a Rudder, serves to steer or move its little Body, is very large; the Sides or Edges of it are thin and transparent; and down its Middle there runs a thickish hard Substance of a brownish Colour.*

N^o 12. *In this View we see the hind Feet longer, one of the Fore-legs half out, and the other just beginning to protuberate thro' the Skin.*

N^o 13, 14, 15. *Do all represent the Tadpole, gradually grown bigger.*

N^o 16. *Here the Gyrinus, or Tadpole, is now undergoing its last Change; and as soon as the Tail, which is now almost wore off to a Stump, is quite lost, it assumes the Denomination of a perfect Frog, which*

N^o 17. *Representeth to our Eye.*

P L A T E XXI.

Fig. I. *The Frog fully perfected.*

Fig. II. *The common English Toad.*

P L A T E XXII.

Fig. I. *The Surinam Frog, shewing the Manner of its bringing its young ones, perfectly form'd, out of the Pores, in the Skin of its Back.*

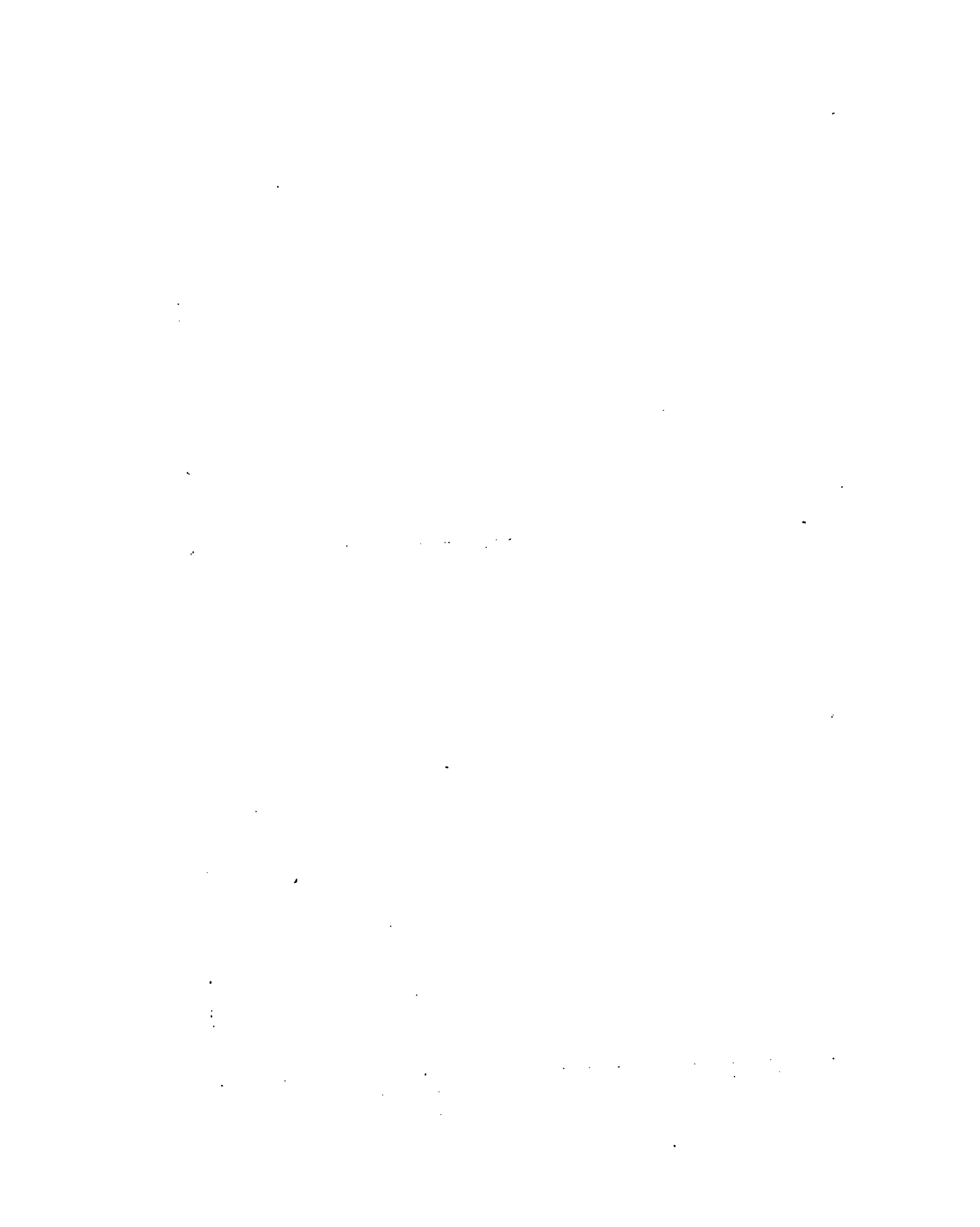
C H A P.

Fig. I.



Fig. II.





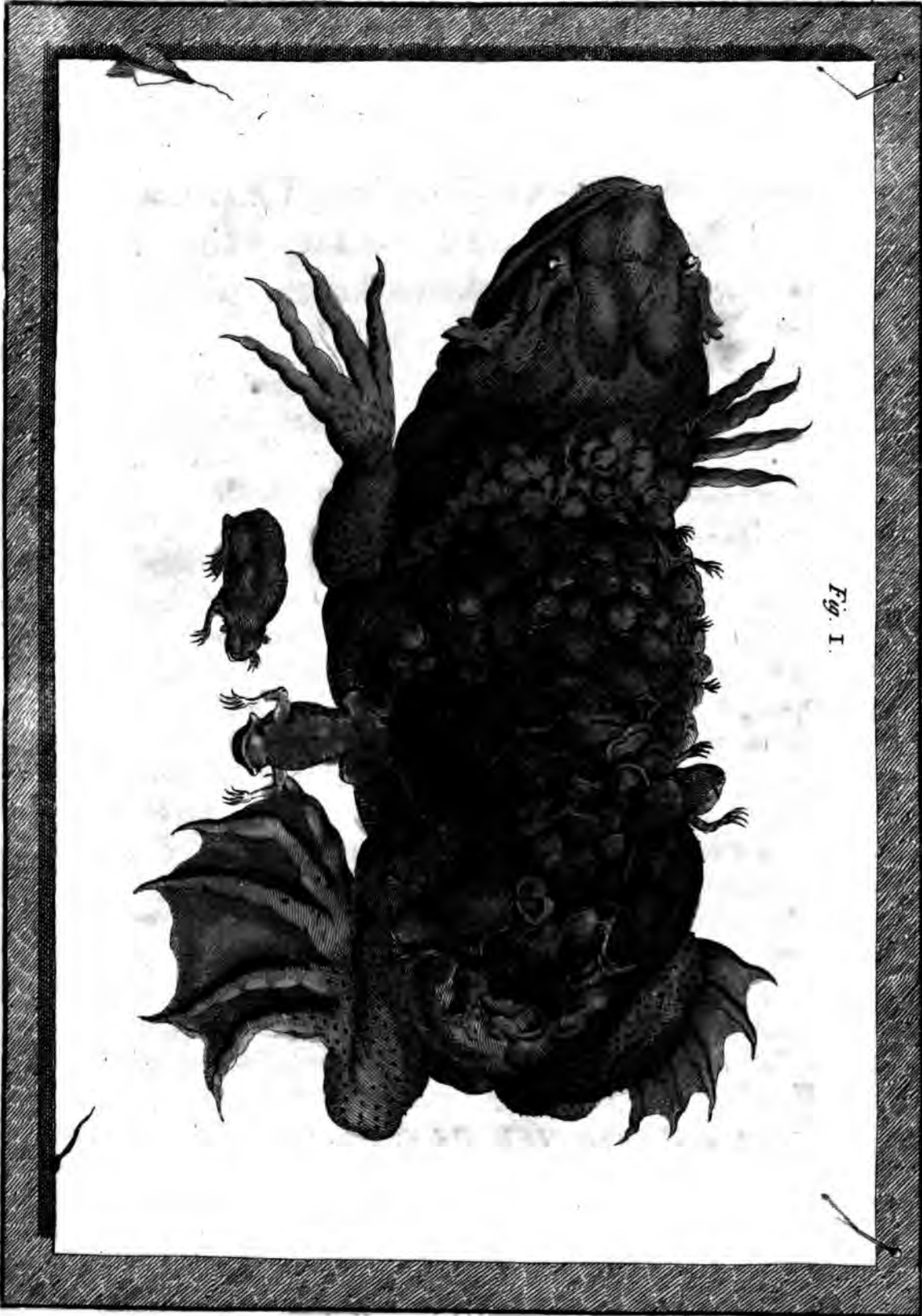


Fig. I.

J. Cook, Sculp.

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C H A P. XI.

Of SNAILS, EARTH-WORMS, CENTIPEDES, MILLIPEDES, SPIDERS, and *Insects without Wings, which may be stiled Irregular Insects.*

THE Contents of this Chapter have very surprizing Particulars, differing almost in every thing from all other created Bodies. The *Snails*, which I shall first treat of, have indeed some little Affinity to *Animals*, such as the hatching of their young ones at once perfectly form'd; they are *Oviparous*, but the manner of their Coupling is extraordinary: Every single *Snail* possesses the generative Parts of both Sexes, and makes use of them equally when they couple: The Situation of these Parts is on the left side of the Head; but are only to be discovered when they are generating, which is about the middle of *May*; they remain in Copulation about twelve Hours, and are then hardly to be separated without wounding their Parts: about three Weeks after this Act is over, they make their way into the Earth, and lay their *Eggs* in Knots of about thirty in number, near four Inches deep; for this they commonly make choice of a moist, shady Place, in which Station their *Eggs* are hatch'd in about a Month, and the young *Snails* then appear above Ground. The manner of their meeting to couple is well worth observing; in *dewy* Evenings, or after a Shower of Rain, they crawl upon the Grass in a circular manner, making several Rounds, till they come near enough to one another to hit their Design; I have observed them sometimes make above twenty Turns before they could join. The *Dew Snails*, and what the Garden-

ers

ers call *Slugs*, have all of them the same Mode of Generating as we observe in the *Shell Snail*, which is of several Kinds, with regard to the Consistency of their Flesh, and Colour and Variations of their Shells; but upon their first hatching they are so very tender, that the Weight of a few Grains would crush them out of Form; and it is hard at that time to make any Distinction between the different Kinds. Their Flesh is of a spongy Texture, and the Juices which afford it its Nourishment are viscous which I suppose may be one Reason why the Motion of *Snails* is so very slow, that kind of Juice being of too thick a Substance to circulate quickly. I have been informed, that the most intense Cold, which can be produced, either by Nature or Art, cannot freeze the Juice of *Snails*; but I think all viscous Matter is hard to be congeal'd; for I do not find that *Bird-lime*, if it is in any considerable Body, will freeze, if it be expos'd to the coldest Air, no more than the *Berries* of the *Mistletoe* or *Viscum*, whose Season of Ripeness is in the coldest time of the Winter; but other *Seeds*, whose Juices are more aqueous, are spoil'd by a little Frost. The Food of all this Race is tender *Leaves*, and young *Sprouts* of *Plants*, which they devour, by means of a Tooth-like Body growing in their upper Jaw, with which they rather scrape the *Leaves* to pieces than macerate them; for there is no sign of any Teeth in their lower Jaw. In the twenty third Plate I have given a Figure of the *Teeth*, but especially of the generative Parts, as they appear at the Time of their Coupling; both done with a *Microscope*.

The better to discover the Degree of Life in these Creatures, whose Circulation of Juices seem slow enough to come nearer to a State of Stagnation, than the Motion of Juices in other Animals, I have endeavour'd to find out the Situation of the Heart, and to compare its Motion with the *Beats* of a *Pendulum*. The first Subject I met with, which gave me the View of this Part, was a small *Snail*
just

just hatch'd, whose *Body* and *Shell* were so transparent, that I could discern its *Beats* to be distant about three Seconds; but as I supposed the Juices in this were much more fluid than in the older *Snails*, I had recourse to some of the largest I could find; but their *Shells* not being transparent, I was obliged to take them off as well as I could, without wounding the *Snails*; and then on their left Sides I plainly discover'd the *Beats* of the Heart to be about five Seconds of time distant from one another, and three Hours afterwards about seven Seconds, tho' some of them were then strong enough to begin the renewing of their *Shells*, which they effect, by flinging out a large Quantity of *viscous* Matter thro' the Pores of that part of the Body which had been encased before. The Motion of these Creatures is perform'd by repeated Undulations of their fleshy Parts, without the help of any *Feet* that I can discover; this undulating Motion presses a *viscous* Matter out of their Pores, which serves to give them hold of any thing they crawl upon, and helps them in their creeping up the Sides of *Walls* or *Trees*, and even when they reverse their Bodies, and creep upon *Ceilings* with their *Shell* downwards. But it is observable, that a *Snail* seldom has any Motion but when it is in search of Food, or is about Generating, and then it is only when the Ground is wet, and it has Opportunity of supplying its lost Juices by fresh Food. I have remark'd, that when a *Snail* is obliged to pass over a dry dusty Place, it loses so much of its *viscous* Juice, that it can hardly recover it again.

The next I am to take notice of is the *Earth-Worm*, whose Shape is long and round, and their Bodies composed of several *Annuli*, jointed in one another, upon some of which some curious Men have observ'd little *Feet* or *Asperities*, with which it is supposed they take hold of the Ground as they creep along. This *reptile* Motion, as Dr. *Tyson* observes, may be explain'd by Wire wound on a *Cylinder*, which when slit off, and one End extended and held fast, will bring the other nearer it. In this manner

the *Earth-Worm* having shot out or extended its Body, (by a sort of wreathing) it takes hold of the Ground with its small *Feet*, and so contracts the hinder part of its Body. These Creatures cannot bear Heat no more than the *Snails*; and seldom are seen out of the Earth but when they are disturb'd, or when a Dewy Evening or wet Weather invites them to couple, and even then they do not entirely quit their Holes, but extend their Bodies as far as they conveniently can, to reach one another, and couple much after the same manner as *Snails*, *i. e.* by performing each of them the *Male* and *Female* Duty. But I have not yet been nice enough in this Enquiry, to determine whether they are *Oviparous* or *Viviparous*.

After these we may next take notice of *Jointed-Worms* with many *Feet*, which are call'd *Centipedes* and *Millipedes*: these have always their Habitation in shady moist Places; chiefly in rotted Wood, and under Logs, or amongst Rubbish. Our *English* Kinds of *Centipedes* are about two Inches long, consisting of about thirty *Joints*, every one of which has two *Legs*, as small as *Hairs*, so that they have in all about sixty *Legs*, which they move alternately; and yet for all this mighty Number are but slow in their Motion, compared with other *Insects*. In the *West Indies* there is a kind of *Centipes* about eight Inches long, when it is full grown, whose Figure I have taken from one now in the Royal Society; but how these Creatures are produced, I have not yet had an Opportunity of observing, no more than the Generation of those Creatures call'd *Millipedes* or *Wood-lice*, which, tho' they bear that Name, have not above half the number of *Legs* that we observe in the former: their Bodies are cover'd with *Jointed Scaly* Substances, which give them something of the Figure of an *Armadillo*; but I never observe the Parts of these to alter as those do among the regular *Insects*, which I shall treat of in the next Chapter.

I come now to mention the *Spiders*, another Tribe of *Insects* which is very numerous, there being above a hundred and forty different

different Kinds of them in *England* only, as the curious Mr. *Dandridge* of *Moorfields* has observ'd and delineated. 'Tis observable in this Race, that they are all wanting of that part which we might properly call the *Head*. As the Bodies of regular *Insects* are commonly divided into three Parts, (*viz.*) the *Head*, the *Stomach*, and the *Tail*: These for the most part have their Bodies divided only into two, resembling as it were the Bodies of *Bees* or *Wasps* without their *Heads*; but about the place where the *Head* should be set upon the Bodies of *Bees* or *Wasps*, i. e. the Passage immediately into the *Stomach*, we observe two *Feelers* or *Antennæ*, with Tooth-like *Jaws*, for the pinching and masticating their Food. Upon the Upper-side of the same part we discover their *Eyes*, which are commonly eight in number, and differently placed, as the *Spiders* are of different Make. The *Long Legs*, which is of this Tribe, has its Body undivided, and no sign of any *Head* no more than the rest. Mr. *Dandridge* observes that this Kind has but two *Eyes*; and I have not remark'd that it is fond of Motion, but remains constantly in the same place where it is hatch'd, unless it be provok'd or disturbed. 'Tis remarkable that all our *English Spiders* have eight *Legs*; but those which we receive from the *West Indies* have ten. Among *Spiders* we may further observe, that as they are of different Classes, they have different Modes of Motion, and of catching their Prey; one of the smaller sort jumps from place to place; another Kind, after running about a Yard, makes a full stop, and then running about the same Length stops again; others are so very quick, and continued in their Motion, that they will run about ten Yards in two Seconds of time. Again, we may remark, that such Kinds as have *Webs* have different Manners of composing them; some of them are of the Figure of a Tunnel-Net, disposed for catching all kind of *Flies* that come into it, the *Spider* himself lying out of sight: These Kinds are commonly found in Houses, and are more voracious than any of the other Kinds.

Another sort makes his *Web* almost of the Figure of a Casting Net, and places himself always in the Center. The Regularity and artful Contrivance in its composing this *Web*, together with its surprising manner of passing from *Bough* to *Bough*, without any help but the Air to lay its *Foundation Threads*, is well worth our while to observe, and perhaps may have given some Assistance to the Inventors of Weaving or Knitting.

We have many Accounts of the Flight or Sailing of *Spiders* in the Air, by means of their *Webs* or *Thread*; but I have not yet had an Opportunity of observing it as I would do. I have measured the *Webs* of some of the larger Kind of *Spiders* in *England*, in one of which there was above forty eight Yards of *Thread*; another contained about forty six. It appears by Mr. *Dandridge's* Collection that we have but nine different Classes of *English Spiders*; one of each Class is engraved in the twenty fourth Plate: in the same I have also given a Cut of the *Tarantala*, taken from that in the Royal Society, which *Spider* is said to be very venomous, and has given Rise to many Relations, which I account fabulous; but there is no Creature of this Race which I esteem more extraordinary than the large *West Indian Spider*; which measures sometimes above five Inches over, as may be seen in Dr. *Ruysh's* Cabinet at *Amsterdam*; it has ten *Legs*, covered with long brown *Hair*, which gives it a very frightful Aspect. It is said that the *Web* of this *Spider* is strong enough to catch the *humming Birds* which it preys upon.

Among the *Insects* of this Chapter I cannot help mentioning the *Ant* or *Pismire*, whose Industry and Cunning may afford us sufficient Matter for Observation. 'Tis one of those *Insects* which either sleeps the Winter, or is laid up at that time; but I the rather believe the latter, because of its Care in providing and laying up Food. There are several sorts of *Ants*, some of which are larger than our common House *Flies*; these are call'd *Horse-Ants*, and are seldom fewer than five or six thousand together: their

their Habitation is commonly under the *Roots* of great *Trees*, where they may best live undisturbed. They feed commonly upon dead *Insects*, or *Carrion*, like the common small Kind, and seem to agree with them in every respect but their Size. If we open one of their *Nests*, we discover Galleries and Passages in several Ranges one above another; but yet all so disposed as to have a free Communication one with another. 'Tis observable among these Creatures, that if any of their own *Brood* happen to be kill'd, they immediately remove him from their Habitation; and if they meet with any dead *Insect*, or other proper Food in the Course of their Travels, they find means to bring it home, although it be very distant from their Apartments. There is no better way to prepare the *Skeletons* of *Mice*, and other small *Animals*, than by fixing those Creatures in a right Posture in a little Box with Holes in it, and burying it among these *Ants*, which, in a few Days, will clear the Bones of all the Flesh; so that they are able to perform what scarcely the finest Knife in the World can execute. This sort of *Ant*, as well as the smallest Kind, is hatch'd from an *Egg* about *June* or *July*. I have observed, that in the Mornings, as soon as the Sun begins to have some Influence, the whole Colony is employed in bringing up their *Eggs* to the Surface of their Hill, that they may be within Reach of the Sun's Warmth; but as soon as the Sun begins to decline, they renew their Labour, and return their *Eggs* to the lowest Caverns to lie safe from the Evening Cold; and this they do every Day when the Weather will permit, till their young ones are hatch'd. I am here at a Loss, to know whether those which are winged among them, at that time, are the Young or the Old; but it is certain, that those which have *Wings* leave the rest in a few Days, perhaps to seek some other Habitation. It is remarkable, that the common small *Ant* will often frequent Houses in search of their Food; and if they are lucky enough to find out Sugar or Sweet-meats, their whole Tribe are soon apprized of it,
and

and follow them to the place. A noble Lord gave me a remarkable Instance of it: A *Nest* of these Creatures in his Garden discovered a Closet of Confections many Yards within the House, and had a constant Recourse to it, by a certain Road which they traced out through two Rooms, which they observed so exactly, that they hardly varied an Inch from it; and what is most remarkable, these Creatures continued for some Days the same Route, notwithstanding the sweeping and cleaning of the Rooms, they pass through, till the whole *Nest* was destroyed.

I have observed one sort of *Ant* which lays its *Egg* in the Back of the *Oak Leaf*, and raises the Blisters in those *Leaves*, which we call the *Oak-Berries*; those *Berries* are round, and about the Bigness and Consistency of a half-grown *Grape*: In every one of these is a single *Insect* perfectly form'd; so that it appears it has no Change after hatching.

I may yet add to this Chapter the *Ear-wig*, which we have not yet remark'd to have any Change of Figure after it is once hatch'd; but only when it is full grown we may discover its *Wings* folded up in small Cases upon the middle of its Body, as may be observed at Mr. *Dandridge's*. I shall now proceed to consider those *Insects* which we may call *regular*, such as those of the *Papilionaceous*, *Bee*, and *Fly* Kinds.

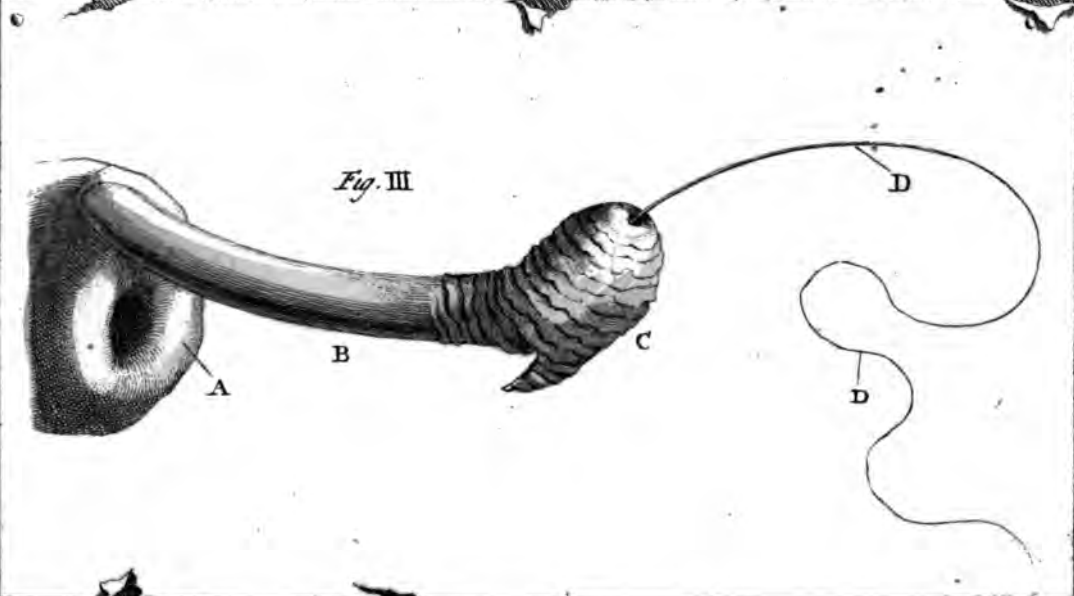
Explanation of the Plates relating to this Chapter.

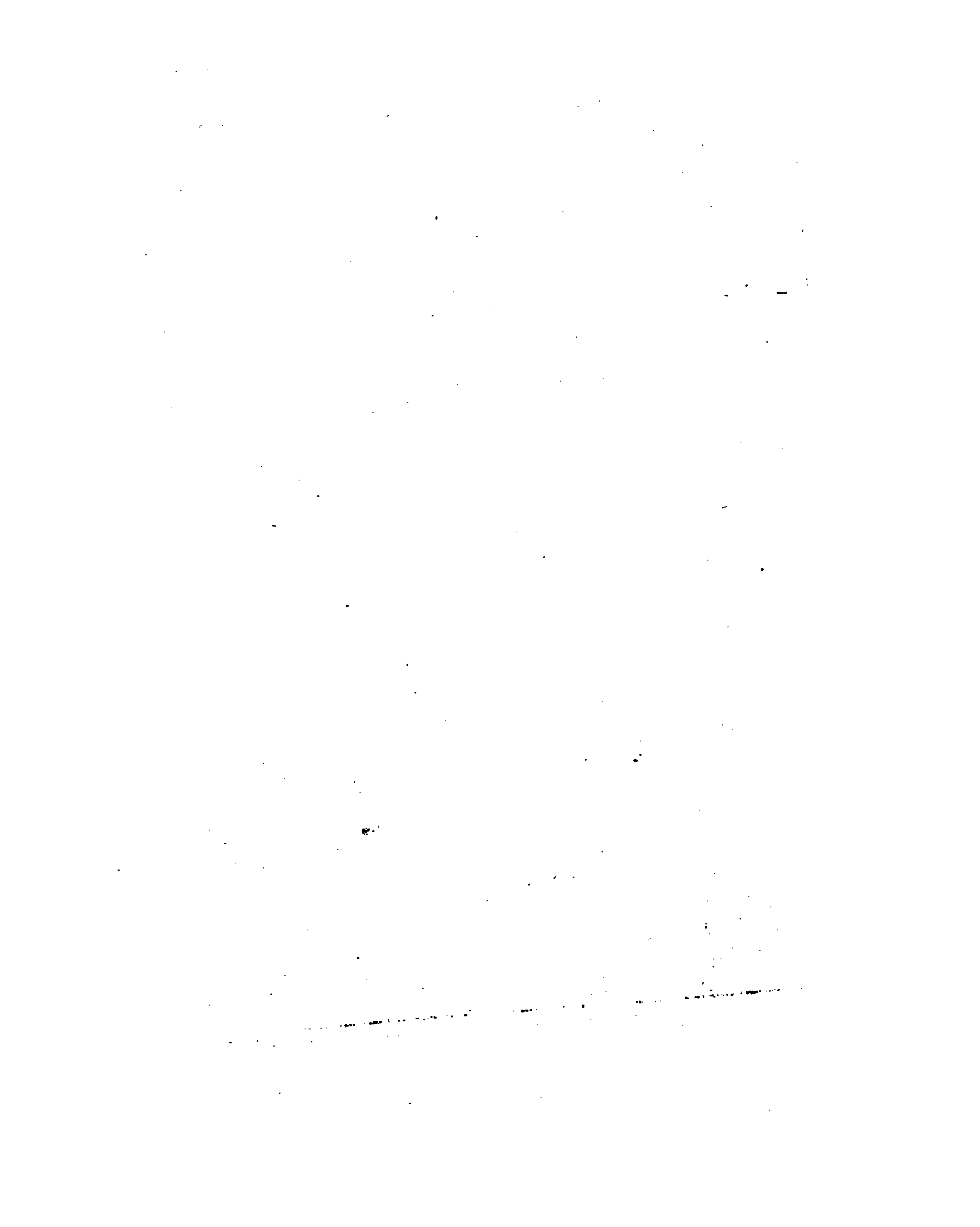
P L A T E XXIII.

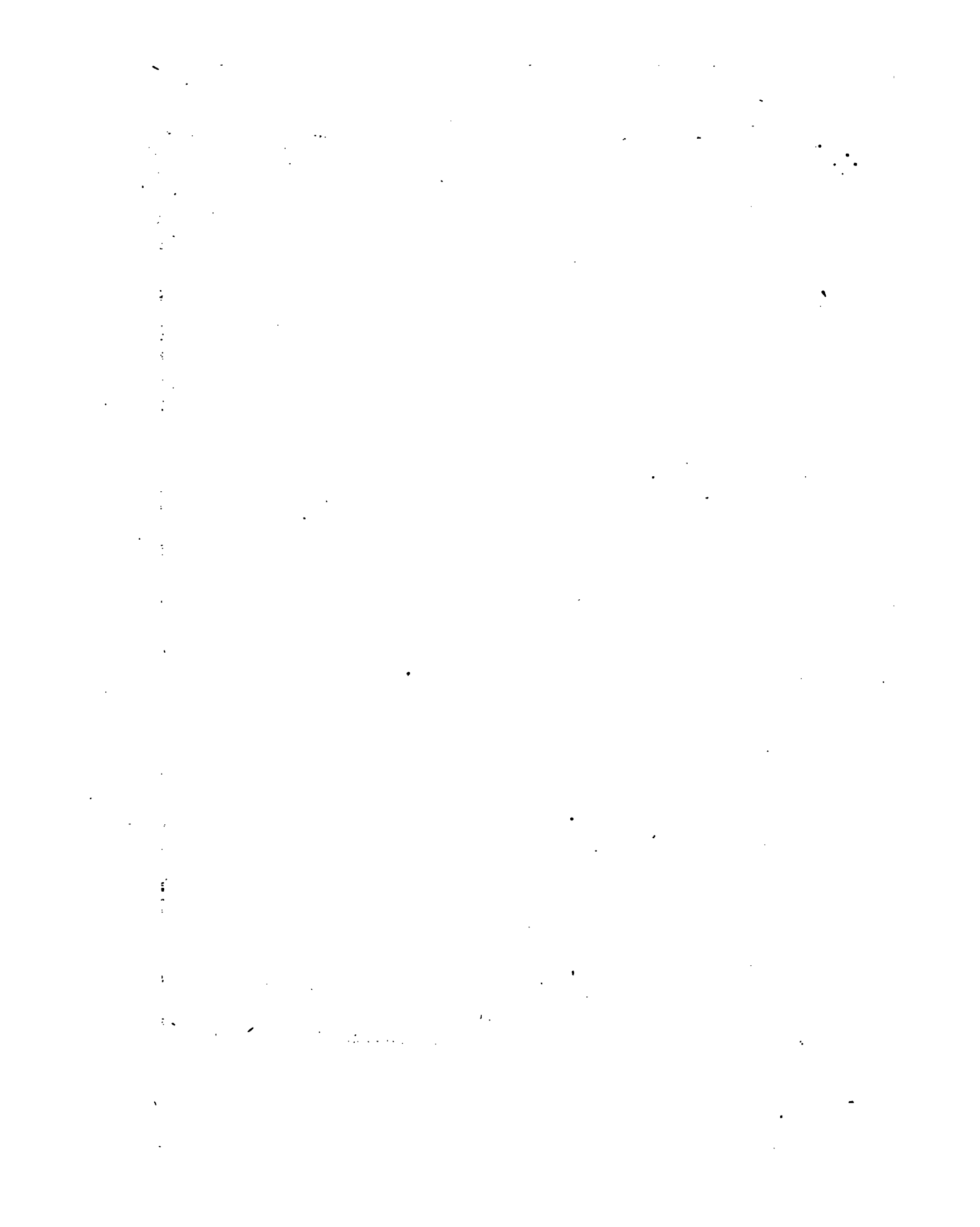
Fig. I. *A Land Snail in a creeping Posture.*

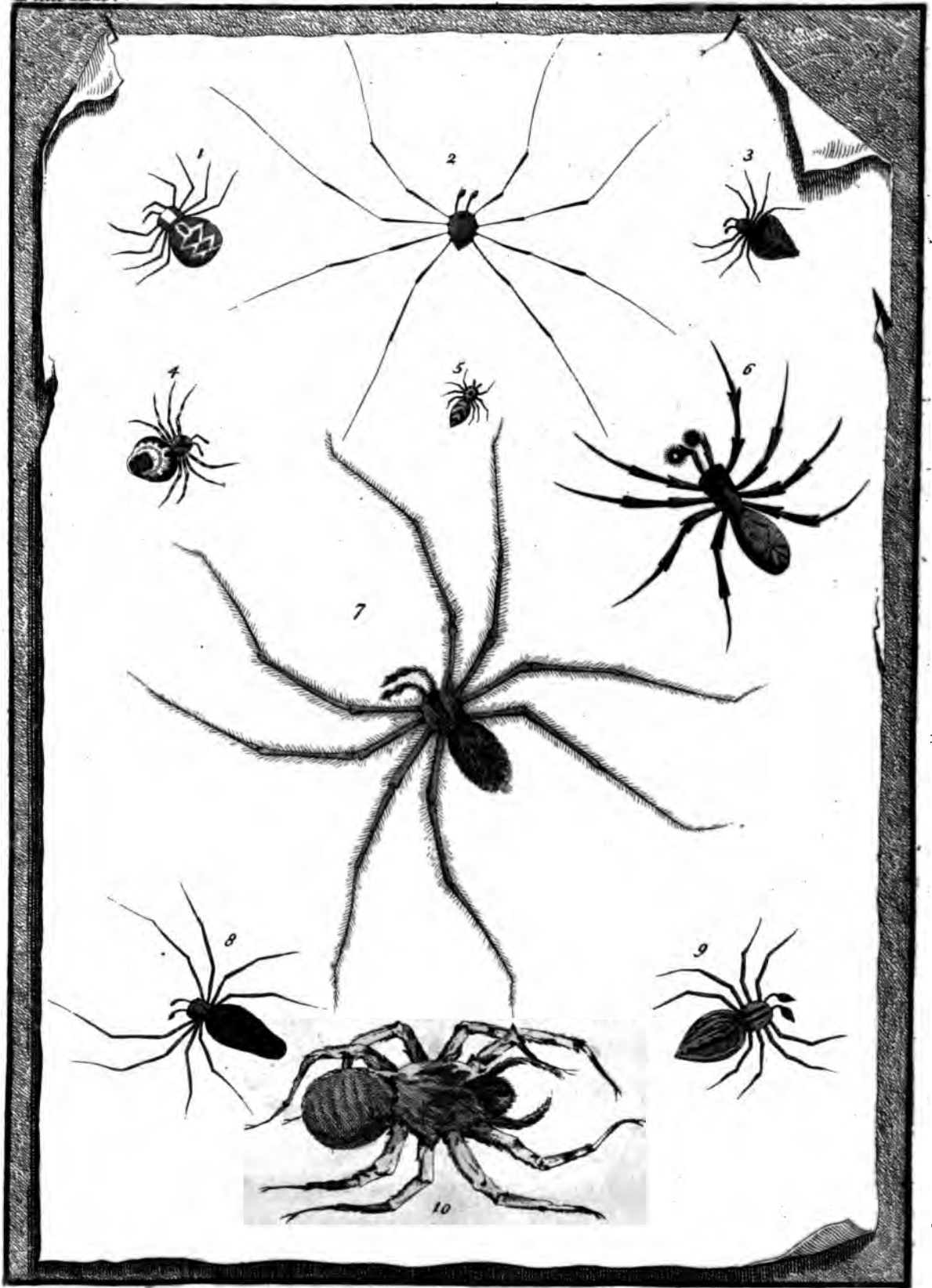
Fig. II. *The Teeth of the same Snail in the Upper-Jaw, done with the Microscope.*

Fig. III. *The Male and Female Parts of Generation in the same Snail. A: The Orifice of the Female Part. B: The Tube of the Male Part. C: The Glans of the same. D: A Wire-like*
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C H A P. XII. and XIII.

Of the Papilionaceous or BUTTERFLY kind; and of BEES, FLIES, and some others observ'd with the Microscope.

AMONG the Creatures which have Life and Motion, we do not find any that possess a greater Share of Beauty in the Colours of their Cloathing, nor a more exact Symetry in the Arrangement of their Parts, than the *Insects* which make the Subject of this Chapter. To this we may likewise add the surprising Changes of those Creatures, between the time they are in the *Egg*, and the taking *Wing*. Those of the *Butterfly* kind are most commonly mark'd with the gayest Colours; and the *Moths*, which are regularly mark'd and variegated, have an agreeable Disposition of the graver Colours: But however these are grave, or the others gay in the Colours they are adorn'd with, there is so just a Harmony between one Colour and the other, that we can never say the Grave is dull, nor the Gay surfeiting or unpleasant. Both the *Butterfly* and the *Moth* have their *Wings* adorn'd with *Feathers*, as regularly disciplin'd as those in the *Wings* of *Birds*, tho' they are hardly to be discerned without the Assistance of *Microscopes*, and is that which is falsely call'd the *Dust* of their *Wings*. The Bodies of the first are divided into three Parts, (*viz.*) the *Head* join'd by a tender *Fillament* to the *Center* or *middle part* of their *Body*, and that again is more strongly join'd to the *Tail*, which consists of many *Annuli*. The Bodies of the *Butterflies* are long and thin; but those of the *Moth* kind are thick and short. All of the first Race have long slender *Antennæ* knotted at the Points; but the *Moths* have their
Antennæ

Antennæ short and feathered. And we may again make this Distinction between these two, that the *Butterflies* always fly in the Heat of the Day, and the *Moths* after the Sun is down. And I am the rather thus full in the Particulars of these Creatures, when they are in the *Winged* State, because it is necessary to speak of the Manner of their Generating before I treat of their *Eggs*. The Life of these Creatures, in this State of Perfection, is much longer in the *Butterfly* than in the *Moth* kind. I have known *Butterflies* live three Weeks; but I have never observed the *Moth* to live so long. The Manner of their Generating is equally performed by Coupling; but Mr. *Dandridge* makes this Remark of the Method of Coupling in *Insects*, that the *Female* always enters the Body of the *Male*, contrary to all Creatures of other Kinds, which he says is the same with the common *Fly*, that we may more easily observe it. Immediately after the Coupling of these Creatures, they lay their *Eggs*, and are so observant (if they are at Liberty) of the Place they lay them upon, that we may be assured it is proper for their Hatching, and convenient for their feeding, when they are in the *Caterpillar*. If we examine their *Eggs* with a *Microscope*, we shall find some of them *transparent*, and others *opaque*: The *transparent Eggs* are *sterile* or *barren*; but the others will hatch at their proper Seasons, if the Weather be agreeable to them. In the case of *Silk-Worms*, it is held by some People convenient to carry the *Eggs* to Church, upon the Festival of a certain Saint, by the Mistress of the Family, who carefully wraps them up in a Cloth, and lays them in her Bosom, till she has performed some particular Duty; the Warmth of her Bosom has so much Influence over the *Eggs*, that they hatch at her return home.

The *Eggs* of all the *Papilionaceous* Tribe have different Length of Time to hatch in, as their Originals are different in other Respects. Some will only lie a few Days, others two or three

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Weeks,

Weeks, and others six or eight Months, without hatching: And again, the *Caterpillars* or *Nympha* of these Creatures have different Periods of Time allotted them for growing to their full Proportion; and their Form, in their *Nympha* State, are every one respectively agreeable to their several Tribes, and have some of them in that State the Appearance of eight and ten *Legs* a-piece, although they never exceed six in number when they come to have *Wings*. They are frequently variegated with beautiful Colours, and often surprisngly clothed with *Hair*; and yet it is not to be observed, that either the *Hair* or *Colours* they possess, while they are in this State, is any way agreeable to what we find in them when they have got *Wings*: Nor indeed can we expect to find them strictly the same, because, while they are laid up in the *Chrysalis*, every part of the preceding *Caterpillar* seems to be reduced to a State of Confusion, much more than we can imagine it was even in the *Egg* or unhatch'd State. All these, during the Time they are in the *Nympha*, feed upon the *Leaves* or *Flowers* of *Plants*: And we find by Experience, that Nature has appointed each particular Kind of *Insect* to feed only upon a particular *Plant*; and even the same *Insect* that is appointed to feed upon the *Leaves* of a *Plant*, will not feed upon the *Flower* of the same; but the *Flowers* have equally different Kinds of Destroyers as the *Leaves* have; and I think such as feed upon the *Blossoms* or *Flowers* of *Vegetables* change commonly into *Moths*; but the *Leaf Eaters* are for the most part *Butterflies*. Some of these, when they change from their *Caterpillar* State into a *Chrysalis*, enclose themselves in Silken Bags; others make their Retreat under some Shelter; and others make their way into the Earth while they are in this State. Their Figures are all different, as were their *Nympha*. And as the Time required for the hatching of the *Eggs* of the several Kinds is as various as themselves, so likewise the different Periods of Time necessary for the changing them from this stupified State to that of the *Fly* are as different;

different; some of them only remaining thus for a few Days, others a few Weeks, and others some Months. What I here take notice of relating to the Food and Manner of breeding of *Insects*, especially that every distinct Kind of *Insect* has a *Plant* peculiar to its self to feed upon, I first learned from that excellent Lady the late Dutchess of *Beaufort*, whose Curiosity and Skill in Natural Knowledge gave Life to many Discoveries, which, without her happy Influence, would have lain uncultivated and useless to the World. This Lady had seen the Progress of many Kinds; and I believe has bred a greater Variety of *English Insects*, than were ever rightly observ'd by any one Person in *Europe*.

When the *Papilionaceous* Race has got so far as to enjoy the Power of Flight, their extraordinary Frame and Colouring will afford us Matter enough for Admiration, especially if we could have Opportunity of contemplating those surprising Collections of Sir *Hans Sloane*, Mr. *Vincent*, Dr. *Ruysh*, and Mr. *Seba*, where we may observe many thousand Varieties of Foreign *Insects*; and also in that curious Cabinet of Mr. *Dandridge*, who has so industriously collected the *Insects* of our own Country: Some of the *Moth* and *Butterfly* Tribe being so large as to measure eight, nine and ten Inches between the extream Points of their *Wings*, especially among those which breed about *Ambonia* in the *East Indies*, and might certainly be propagated with us if we had the proper *Plants* to feed them with, and perhaps might produce something as useful as Silk, if we were to enquire into them. But while that Opinion reigns in the World, that we know enough already, and thereby the Search of Novelties is made ridiculous, we must be content to let many valuable Things lie undiscover'd, as the *Magnet* did for many Ages. How useful are several *Earths*, *Vegetables*, and *Insects* in Medicine, and in some other Cases already discover'd; and why may we not hope still to discover the hidden Virtues in other such like Bodies. The *Silk-Worm*, at present, carries the Day before all
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others

others of the *Papilionaceus* Tribe, as it furnishes the Principals of the gayest and richest Cloathing, altho' the Creature it self has the meanest Appearance of any of its Class. . . I could instance many Particulars in this Place relating to the manner of breeding them, and of the Service they may be of to this Nation, if the Design, now begun at *Chelsea* for raising them, continues to be encouraged; but as Mr. *Barham*, F. R. S. one of the chief Undertakers of that Project, has already written largely of them, and continues daily to make new Discoveries and Observations, I rather chuse to refer my Reader to the Works of a Gentleman, who has so much Experience in the Matter. . . It is enough to say of this Race, that they seldom fly higher than ten or twelve Yards from the Ground. And we may further remark, that the *Butterfly* and *Moth* Kinds never keep in Flocks, as some other *Insects* do, altho' perhaps five hundred are hatch'd together from the *Eggs* of one *Dam*.

Mr. *Dandridge* observes that there are gradual Alterations from a perfect *Moth* to the *Bee* kind; and indeed, if we examine the twenty sixth Plate, taken from his Cabinet, we may observe a just Progression from one to the other. The *Antennæ* of all are alike, and their Bodies are just different enough to be distinguish'd from one another, bearing about the same Proportions of Difference that an *Horse* does to a *Mule*, and a *Mule* to an *Ass*. The *Wings* are four in each, those of the *Moth* feather'd all over: Next to which is a degree of *Moth* with transparent *Wings*, feather'd only about one fourth part: The third with *Wings* like the second, but thinly feather'd on the Edges. And lastly, the *Humble Bee*, whose *Wings* have no *Feathers*; and so I doubt not but we might proceed as gradually thro' the *Bees*, *Wasps*, and *Ichneumon* Kinds to the *Flies*, and such as have only two *Wings*.

But I come now to speak of *Bees*, from whose industrious Race we are supply'd with Food, as the *Silk-Worm* contributes to our
Cloathing.

Cloathing. The Industry of the *Bee* has given some Authors occasion to write largely of them; and such as have Glass Hives meet daily with some new Discovery worthy their Contemplation. The Method of building their *Combs* is so mathematically disposed, that the Skill of the greatest Artist cannot exceed the Justness and the Beauty of its Contrivance. The Hexagonal Figure of the Cells which compose the *Comb*, is such as leaves no Vacancy or Space unemploy'd; but each respective Side of one Cell serves equally to make good a part of another, as it is well explained in the Account of *Bees*, in the *History of the Royal Academy of Paris for the Year 1712*. The Matter of which the *Bees* make their *Wax* is chiefly the *Farina Fecundans*, or *Dust* of the *Apices* of *Flowers*, which they gather in small Parcels; and lodge in the Cavities of their *hind Legs*, and even upon the *Hairs* which are dispersed here and there upon their Bodies; for which reason I suppose that *Bees-Wax* may contribute greatly to Vegetation. Upon the coming home of one of these laden *Bees*, we may observe how readily he is discharged of his Burden by others of the same Colony. I have seen about ten or twelve *Bees* at work, to discharge one single *Bee* of the *Wax* he has brought home, and convey it to others which were employed in building and framing the Cells; nor is their Labour in gathering the *Honey* from the bottom of the *Flowers*, nor their Discharge of it from their Bodies into the prepared Cells, less admirable. The Manner of their Breeding is yet Matter of Dispute. Some Authors tell us, the *Queen Bee*, which is always larger than the rest, is both *Mother* and *Queen* to the whole Colony; whereas, on the other hand, the chief *Bee* of a *Hive* is stiled the *King*: But however this be, we find by Experience, that where this Governour is wanting, and has by Accident been destroyed, the whole *Hive* decays and comes to Ruin. I have with great Pleasure admired many of their Ceremonies about the Time of their Swarming, especially three or four Evenings before they are going out:
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The *Queen Bee* appears at the Mouth of the *Hive*, and is guarded at that time by four or five Ranks or Files of *Bees*, which stand before her in strait Lines, fluttering their *Wings*, and making a Noise, without moving from their Place, leaving room enough between the Ranks for the labouring *Bees* to pass backwards and forwards. The Time of their Swarming is commonly in *May*, unless we have a degree of Heat before that Season which is equal to the Temper of Air at that Time, as it sometimes happens in *February* or *March*. A curious Observer of *Bees* tells me, that he has known it practised, when a Swarm is inclinable to fly away, to sling Dust among them, or, if they are out of Reach, the firing of a Pistol will make them settle immediately; which, I think, carries reason enough along with it, considering how much an approaching Storm makes them hurry home to their *Hives*; I suppose, by pressing the Air in an extraordinary manner, such as the firing of a Gun or Pistol will do. I could say much more relating to their Oeconomy, their Battles, Robberies, Manner of Burying their Dead, and destroying their Drones; but I rather refer my Reader to those curious Remarks above mentioned, in the Academy of *Paris*, and other Books lately published concerning *Bees*, than trouble him with a Repetition of what is already printed. The Body of the *Bee* is divided into three Parts, very tenderly join'd together; the middle Part seems to contain the greatest of their Strength, and in it seems to be the chief Residence of the Motive Power: To it are join'd the *Legs*, which are six in number; and the *Wings*, which are always four in the *Bee* Race, or such as have Stings like *Bees*. Some of the *Humble Bees* which come nearest in Form to the *Honey Bee* have Stings; but others more remote from that Figure have none. The *Wasp* and *Hornet* are in most Particulars like the *Tame Bee*, and are not without the Skill of composing their *Cells* and *Combs* in as artful a manner as those of the *Bee* kind; but their Order and Discipline in other Matters
does

does not seem so regular. All this Race have a Power of walking up such Surfaces as are as smooth as a well plained Board.

It is observable as well in the *Wasp* as in the *Bee* kind, that if we cut their Bodies to pieces, every Part will retain Life for many Hours, such as I have observed in the Flesh of *Eels* and *Vipers*; which seems to agree in some measure with the Life in *Vegetables*, whose several Parts, being separated from one another, will retain their Verdure for a long time, and even be disposed to grow, if they are managed according to Art.

Next to these we may place the *Ichneumon Flies*, which have generally four transparent *Wings*, six *Legs*, and the Body divided into three, and joined by tender Vessels like the *Bee* kind: Some of these lay their *Eggs* in the *Parenchymous* Part of *Leaves* and *Fruit*; others in the *Nympha* or *Caterpillar* of *Insects*; every one of them having a proper *Matrix* for the hatching of its own *Eggs* or *Nidus*, distinct to it self, in some living Body considerably different from it self. I observe, that such as lay their *Eggs* in the *Leaves* or *Twigs* of *Trees*, do that Work while those Parts of the *Plant* are very tender, which they wound in such a manner, and sprinkle with a *Liquor*, which they emit when they lay their *Egg*, as changes the first *Vegetative* Intent, and disposes the Parts of the *Leaf* or *Twig* to produce an uncommon Appearance, such as the *Blisters* upon the *Leaves* of *Oaks*, called *Oak-Berries*, and those *Excreffences* call'd *Oak-Apples*, which are occasioned by these *Insects*, and serve as *Nests* to enclose, nourish, and hatch their *Eggs*. Those of the *Ichneumon* Race, which lay their *Eggs* in the Bodies of *Caterpillars*, have no further Care for the hatching of those *Eggs*; the Body of the *Caterpillar* affording them every thing necessary, as well for their Hatching as their Nourishment, till they are fully perfected. Among the *Insects* I have bred, I have found many of the *Ichneumon* Tribe come out of the *Aurelia* of the *Butterfly* and *Moth* Kinds, after having devoured all the Moisture of the Mother In-
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sect which they were hatch'd in; which has made some mistake the *Aureliae* of certain Kinds of *Butterflies*, to be the *Aureliae* of *Ichneumon Flies*.

We next come to consider the *Beetles*, a Race of *Insects* whose first Food is, for the most part, the *Wood* and *Bark* of *Trees*: These have as many Changes as the former: The Structure of their Bodies is in some Respects agreeing with those of the *Bee* kind; the Bodies of these being divided into three, but more strongly united together: The Case of the Bodies in these are hard and substantial; their *Legs* are always six in number, composed of a hard *Horney* Substance; they have two Pair of *Wings*, the uppermost very hard and strong, which serve for Cases for the other two, which are thin and transparent, and are so disposed as to fold up or explain themselves at the Will of the *Insect*. Their *Crest* or *Head* is hard, and commonly shining, and in most of them black as *Jett*, and of very surprising Forms; some of them having *Pinchers*, like the *Horns* of *Bucks* and *Stags*; others have their *Heads* imitating the *Rhinoceros*; others have *Horns* like *Bulls*, and sometimes resembling the *Snout* of an *Elephant*, which makes us distinguish them by the Names of *Bull-Beetles*, *Stag-Beetles*, &c. They have two *Eyes* a-piece, notwithstanding the common Proverb, which tell us they are blind. Their Time of Flight and appearing abroad is in the Evenings; and the great Strength of their *Wings* and *Joints* is very remarkable, being able not only to resist a considerable Force, but even to support their Bodies in the Air, and carry them several Yards, with a Weight in their *Pinchers* of about three or four Ounces, such as a *Wand* of half a Yard long, and about half an Inch diameter, which I have seen our *English Stag-Beetle* fly with several Yards. The *upper Wings* of these Creatures are sometimes very finely variegated; and some of them appear as if they were made of solid Gold, shining through a transparent *Green*, *Blue*, or *Red* Colour. The largest Kind I have yet seen is the *Bull-Beetle*, whose

whose Head and Body measures near four Inches; one of which Kind is now in the *Museum* of the Royal Society. The *Stag-Beetle*, from the *East Indies*, is likewise very large; and the Varieties of this Kind of *Insect* are generally of such remarkable Forms, that I think them no less worthy our Observation than the most curious animated Bodies. The Cabinets of Dr. *Ruysk*, Mr. *Seba*, Mr. *Vincent*, Sir *Hans Sloane*, &c. are stored with these Rarities. Among these cas'd Wing'd Creatures is the *Lady Cow*, which has likewise its Varieties beautifully spotted with the gayest Colours; and what gives me more than ordinary Satisfaction in contemplating this kind of *Insect*, is, because there is good reason to believe the *Cocheneel* is of the same Tribe. The late learned and curious Mr. *Petiver* has often told me, that in several Parcels of the *Cocheneel* he has found a kind of *Lady Cow wing'd* and *perfect*, which he supposed was the *Cocheneel-Insect* in its mature State. And Monsieur *Lewenhook's* Observations, in *Phil. Trans.* N^o 292, gives me a further Confirmation that the *Cocheneel* is an *Insect*; and upon the foot of his Observations I have more than once made use of my *Microscopes*, to examine the Form and Structure of this valuable Creature, by which I was confirmed in many Things related by Monsieur *Lewenhook*, to whose Account I refer my Reader; but cannot help observing, that about three Years ago I had a Present made me of some *Cocheneel* which grew in *Carolina*, and was found upon the *Prickley Pear*, or *Indian Figg*, growing in that Country, by a Slave, who had once been employ'd by the *Spaniards* in catching and ordering *Cocheneel* in their *American* Settlements; and I doubt not but it might be found in many other Parts of *America*, if we knew well how to look for it. By what I could learn from the Gentleman who brought it over, and had seen it grow, the *Insect* is not *wing'd* when they gather it for Use, but rather in its third State, or laid up in its *Chrysalis*; he told me that some hundreds of them were found together in a kind of

Silken Web, which I suppose was of their own Spinning, and seems to determine that they could be then in no other State but in the *Chrysalis*, and by the *Microscope* have an Appearance not unlike the *Chrysalis* of our common *Lady Cow*. It was found upon Tryal, that the *Cocheneel* from *Carolina* was in every respect as good as that brought from the *Spanish West Indies*. For the better Satisfaction of my Reader, I have given him a Cut of the several Stages of our common *Lady Bird*.

The next Tribe of *Insects* which I shall take notice of, is the *Locust* or *Grasshopper* Kind, whose Race is as numerous as any I have yet mentioned, as may be observed in the above-named curious Cabinets, especially in that of Mr. *Vincent*: their *Case Wings* are not so substantial as those of the former, but are as beautifully adorned. They have all *six Legs* a-piece; the two *hinder Legs* chiefly disposed for Leaping, or raising their Bodies, till they can take *Wing*; but I can give no certain Account either of their Manner of Generating, or how they are brought forth, or proceed to their *winged* State. The Bodies of some of these are about three Inches long; and some sorts that I have seen in Dr. *Ruysb's* Cabinet measure seven or eight Inches. It is observable, that this Race of Creatures have a Chirping Note or Voice, which is not remarkable in any other *Insect*, but the *Pediculus Pulsatorius*, or *Death-watch*: For tho' other *Insects* make a humming Noise, I suppose that to proceed from the quick beating the Air with their *Wings*, such as may be produced by whirling about a Bit of Stick at the End of a String. And altho' the *Master Bee* of a *Hive* may be distinguish'd from the rest, by its different humming Tone, the superiour Size of its *Wings* may as well make his Sound different from the rest, as the larger *Pipes* of his *Throat* (were they to be made use of as *Organs* of Sound) would produce a Note different from the smaller *Pipes* of the others, which are about one third less.

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The next to these I place the *Libelle*, or *Pond-Flies*, or, as some call them, *May-Flies*, or *Cadew-Flies*. The Bodies of these Creatures are divided in three, as the *Insects* treated of before; and the *Tail* part of them is like the rest, composed of jointed *Annuli*: To the central Part of their Body are joined their six *Legs*, and two Pair of *Wings*, curiously wrought, and of a Texture like fine *Gauze*: Their *Eyes*, which employ the greatest part of their *Head*, appear like *Glass*: The Colours of their Bodies are for the most part tending to *Green*, *Blue*, or *Yellow*; and I have not observed above two Kinds of them which have had any *Red* about them. Mr. *Dandridge*, and the late curious Mr. *Petiver*, have both told me, that these *Flies* proceed from the *Cadew-Worms*; but yet I have not been able to trace any one of these *Flies* to its original *Warm*. Nor can I be certain, whether the *Worms*, when they are cast over, as I have mentioned in my Chapter of *Fish*, are then in their *Chrysalis*, or feeding State.

We come now to mention those *Insects* which are always Inhabitants of the Waters, as well in their *Nympha* as in their perfect State, such as the *Water Scorpion*, *Cantharis*, *Water Beetles* of several Kinds, *Boat-Flies*, a *Monoculus*, and *Cramp Spider*, besides several others of surprising Modes and Forms, which may be observed by the Curious. The *Cantharis Aquatica* has but four *Legs* regularly set on to his Body, and the same number of *Wings*, two of them *Case Wings*, and the others *thin* and *transparent*, which Mr. *Dandridge* tells me they have the Power of using even under the Water. The *Beetle* and *Water-Scorpion* are little various in the outward Structure of their Bodies, and have six *Legs* like the *Beetle* Kind upon the Land. But the *Boat-Flies* are very different from all other Kinds of *Insects*, having their *Legs*, which are very long, placed about the middle of their Bodies; which serve as Oars to row them from place to place. The Shape of their Body is so like a common

Wherrey, that it gave them the Name of *Boat-Flies*. 'Tis observable, that this *Insect* always swims upon its Back. Dr. *Desaguliers* once shew'd me many of this Tribe in a Drop of Water, wherein *Leather* had been steeped, which were so small, that the double *Microscope* did not make them appear half an Inch long; and I suspect that they are *Insects* only in their *Nympha* State. At the same time the above ingenious Doctor, in Presence of several Gentlemen, first gave me the Pleasure of observing a wonderful *Insect* which he had found in *Thames* Water, which had but one *Eye*, or perhaps one Globe of *Eyes*, placed in the middle of its *Forehead*. This Creature may be very easily observed in the Month of *July*, which is the common Time of its appearing in great Numbers. Its natural Size is about the Bigness of a *Flea*, which oblig'd us to have recourse to the *Microscope*, for the better viewing its Parts; we then observed that the *Head* was somewhat like that of a *Bird*, firmly joined to the Body, which was of an *Oval* Figure, ending in a pointed *Tail*. The Parts which seem to do the Office of *Legs*, and fling this Creature forward in the Water by regular Springs or Jirks, are almost like the *Claws* of an *Eagle*, and are two in Number, placed on each Side of its Belly: On the fore-part of its Body, near the Head, are placed two *Branches*, resembling the *Dugs* of *Animals*, from which proceed several capillary *Spines*; these I did not observe had any Motion; and if one may judge of them by their Appearance, we might suppose them designed for suckling their Young; for this *Insect* is *Viviparous*, which is contrary to other *Insects* yet mentioned in this Chapter; for we did not only observe the young ones alive in the Belly of the Mother, but likewise saw several of them excluded from her Body. This curious *Insect* I delineated with all possible Exactness, with the Assistance of Dr. *Desaguliers*, and the Gentlemen then present.

The *Gnat* Kind next follows the *Water Insects*, as they live the greatest part of their Time in the Waters: Their Bodies, when they are in the *wing'd* State, are divided like those of *Libelle*; they have six *Legs* a-piece, tho' the Number of their *Wings* is not always constant: Some Kinds having four a-piece, and others but two; but they are all *transparent*, and their Texture much like that of the *Wasp*, or *Bee* Kind. This Difference in the Number of *Wings* is somewhat like that which we observe between the *Bee* and *Fly* Kind; and perhaps we might observe other as remarkable Differences as we do between the *Flies* and *Bees*. The *four wing'd* Kinds having, it may be, *Stings*, or some venomous Quality in them, and the others harmless as *Flies*. The learned Mr. *Derham* has observed above thirty several Kinds, and has remark'd the *Male* and *Female* either *in Coitu*, or has distinguish'd them by their *Antennæ*, or their Bellies, which are always larger in the *Females*, tho' unimpregnated, than in the *Males*. This curious Gentleman has given us a large Account of the Manner of the Generation of *Gnats*, in his excellent *Physico Theology*, where he tells us, ' That the *Cubyces Maximi*, or ' the largest sort of *Gnats*, lay their *Eggs* in *Meadows* under the ' *Grass*; and there is one of the middle sort which lays its *Eggs* ' in dead Beer *Yeast*, &c. but all the rest, which he had ob- ' served, lay and hatch in the Waters. The *Gnat*, which he ' mentions to lay its *Eggs* in dead Beer, hatches some time after ' into *Maggots*, which are so numerous, that the whole *Liquor* ' stirreth as if it was alive, in which were observable, some that ' were larger, others smaller; the larger are the Off-spring of ' our *Gnat*; the others of a small dark colour'd *Fly*, tending to ' reddish, frequent in Cellars, and such obscure Places. All ' these *Maggots* turn to *Aurelie*; the larger of which, of a *Tann* ' Colour, turn to our *Gnat*, which is of the unarmed Kind, ' having no Spear in its *Mouth*; its *Head* is larger than what is ' observed in the common *Gnats*, a longer *Neck*, short jointed ' *Antennæ*,

Antenne, spotted *Wings*, reaching beyond its slender *Abus*; it is throughout of a *brown* Colour, tending to *red*, especially in the *Female*. The chief Difference between the *Male* and *Female* is, (as in other *Gnats*, yea, most *Insects*) the *Male* is less than the *Female*, and hath a slenderer *Belly*, and its *Po- dex* not so sharp as the *Females* is.

That curious Gentleman observes, that such of the *Gnat* Kind as are of the *Water* Race, lay their *Spawn* (some of them) above an Inch long, and half a quarter diameter, which floats in the *Water*; when these *Eggs* are, by the Warmth of the *Season*, hatch'd into small *Maggots*, they descend to the *Bottom*, where they make themselves little *Cases*, which they creep into and out of at pleasure, until they are arrived to a more mature *Nympha* State, and can swim about to seek their *Food*; they are then a kind of *red-Worm*, above half an Inch long; it then enters its *Aurelia* State, and from thence proceeds to its mature State, all as different as to Shape and Accoutrements, as if the *Insect* was three different *Animals*. In its first or *Vermicular* State, it hath a *Worm-like* Body, and swims about by *Curvations*, appearing like the Figure of an *S*; but in its *Aurelia* State it hath a quite different Body, with a *Club-Head*, (in which the *Head*, *Thorax* and *Wings* of the *Gnat* are enclosed) a slender *Abus*, and a finny *Tail* standing at right *Angles*, with the *Body* quite contrary to what it was before, by which means, instead of easy flapping side-ways, it swims by rapped brisk Jirks the quite contrary way; but when it becomes a *Gnat*, no finny *Tail*, no *Club-Head*, but all is made in the most accurate manner for *Flight* and *Motion* in the *Air*, as before it was for the *Waters*.

This Account, as I am satisfied it is exact in most of the Particulars, may lead my Reader into a right Method of observing the others, and perhaps give him an Opportunity of discovering other surprising *Phenomena* in this wonderful Creature. 'Tis some

some of the *Gnat* Kind, in their *Nympha* State, which has oft-times given Occasion to ignorant People to suppose that some Waters were turned to Blood; for I have seen Ponds and Dirches, about *Midsummer*, whose Waters appeared of that Colour, having all their Bottoms covered with these Creatures in their *Vermicular* State, which disappear for some Yards Space upon touching only one or two of them, but creep out again of their *Calls* or *Cases* in a Minute or two, and reflect their *red* Colour in the Waters: their Life is very short in their perfect State; their chief Business then being Generation. I observe likewise, that the Time between the hatching of the *Egg*, and their taking *Wing*, is constant; which may be one Reason why we observe them hovering in Groups over or near the Waters, till they again return to them to lay their *Spawn*. Some of this Kind, as well as the *Cramp Spider*, are able to walk or stand upon the Waters. This Year I met with a kind of *Gnat* that had but four *Legs*, whose Motion was performed in the same manner of that of *Quadrupedes*. The *Wings* of these Creatures, and almost every other *Insect*, explain and expand themselves in a few Minutes, after they are excluded from the *Chrysalis*; and are not fully grown or explained, as some have thought, at the Instant the *Insect* quits the *Chrysalis*. I have observ'd, with abundance of Pleasure, at the first Appearance of the *Moth*, or *Fly*, that their *Wings* were only beginning to bud; but have unfolded and explained themselves to their full State or Bounds of Growth, some in less than two Minutes, and others in three at most, which is a kind of *Vegetation* more speedy than has yet been mentioned; and I the rather chuse to call it so, because we cannot discern that the *Wings* of these Creatures have any Share of *Sensation*, especially such as are *transparent*; and the Method of their joining to the Body of the *Insect*, is somewhat like the rooting of *Plants* in the Earth; they receive their Nourishment from the Body of the *Insect*, by those capillary *Tubes* which make the Junction between the

the *Wing* and the *Insect*. And if we consider further, that the opening and explaining of the *Wings* of a *Moth* or *Butterfly*, is performed in about three Minutes; and that upon the same *Wings* there appears, almost in the very Instant of Time, a regular Plumage or Feathering; we must suppose the Time of the Growth of such *Feathers* must be almost Instantaneous. I have observed some of the smaller Kind of *Gnats*, which have not lived above eight Hours after they had taken *Wing*, having taken them just when they were excluded from the *Chrysalis*, and kept them under a Canvas Case. This Share of Life does not much exceed the Life of the *Ephemeron*, which is said to live but five Hours; but we must at the same time take notice, that both the *Gnat* Kind and the *Ephemeron* have a Share of Life much longer under the Waters, altho' under different Forms. We may see the Account of the *Ephemeron*, with its Natural History and Anatomy, translated by Dr. *Tyson* from the Original of Dr. *Swammerdam*.

I now come to consider those *Insects* which are of the *Fly* Kind, agreeing partly in Figure, and some other Respects, with the *Bee* Race. All of the *Fly* Kind have but two *Wings* a-piece, and are without Stings; they make no Provision for Winter, as *Bees* do; nor do they seem to have any Order or Oeconomy among them: Their Generation is performed by Coupling; they lay *Eggs*, which hatch into *Maggots*, that afterwards lay themselves up in *Aurelia*, and from thence change into *Flies*. The proper *Nidus* for their *Eggs* is commonly Flesh of all sorts, Dung of *Animals*, and whatever yields a Scent like *Carrion* entices them to it; and it is therefore they are so apt to swarm about the *Flowers* of the *Frittilaria Crassa*, that stinks like putrified Flesh, which is the proper Food for the *Maggots* of most *Flies* to feed upon. But it is observable, that all *Insects* are thus carefully led by Nature, to lay their *Eggs* in such Places, where their

their young ones may find convenient Food. There is indeed one sort of *Fly* taken notice of by Mr. *Dandridge*, which tho' the Shape of its Body and Parts seem to agree very much with the common *Fly*, yet its Method of breeding its Young is very different. These *Flies* assemble together, and hang to one another in so great a Number, as to make a Lump or Ball of about three Inches diameter: the Place of their Meeting is always upon some *Twig* over the Water, about *July* or *August*; while they are in that State, their young ones drop from them alive into the Water, after they have devoured all the Moisture in the Bodies of the Mother *Flies*. This *Fly* is of a *greyish* Colour, and is the first of this Figure that I have heard of which is *Viviparous*, or that has its first Stage of Life in the Waters. Mr. *Dandridge* has now a large *Bunch* of them in his Cabinet: From the same curious Gentleman I likewise received the surprising Account of the *Male* and *Female Glow-Worm*, which I delineated from those in his Collection, taken, *in Coitu*, by the Reverend Mr. *Maningham*, in which Creature the *Phosphorus* or glim'ring Light they afford in dark Nights is not more remarkable, than the Difference of Frame and Parts between the *Male* and *Female*. The *Female* is flat and jointed, and is that which we commonly observe in the *Grass* and *Hedges*; but the *Male* has *Case-Wings*, and many Parts agreeing with the *Beetle* Race; but whether it could produce a Light like that of the *Female*, I did not learn. The *Male* of this *Insect* having *Wings*, leads me to a guess, that such of the *Pismires* as have *Wings* are *Males*, and perhaps leave the *Females* after they have made them pregnant, as the *Male Bees* or *Drones* are said to do. In *Surinam*, and some other Parts of the *West Indies*, there is a large *Fly*, which they commonly call the *Lanthorn Fly*, that is said to yield a considerable Light. We have a good Cut of it in Madam *Mariana's History of Surinam Insects*; and the *Insect* it self is common enough in the *Amsterdam* Cabinets, and I think likewise in Sir *Hans*

Sloane's Collection of Rarities; but I do not yet find any rational Account of the Production of these Lights, no more than of that produced by rotten Wood.

The *Ignis Fatuus*, or *Jack in the Lanthorn*, I suppose to be no more than a Group of small enlightned *Insects*, rather than suppose it an enflameable Vapour, as some have taken it to be; for if it consisted of such *Effluvia* or *Corpuscula's*, as rise from the Earth or Waters that were enflameable, and by some Cause or other had taken Fire, they could not be of so long Last or Duration as we find them to be; and besides, we might as reasonably expect, that all the *Effluvia* arising at the same time from the same Body of Water should equally be enflameable as these, and so the whole Surface of the *Pond, Lake, or River* appear all in a Flame at one time. The sudden Motion of this Light from place to place, very much agrees with the Motion observable in Groups of *Gnats*, which move in a Body sometimes very slowly, and at other times drive together with great Swiftness. Happening to discourse upon this Subject with the ingenious Mr. *Godfrey the Chymist*, that Gentleman told me, that he had often observ'd this enlightned Body in some Places abroad, and had caught some of the *Insects* which help'd to compose it. But allowing it to be as I say, the Occasion of the Light in such *Insects* remains yet to be discovered.

But this strange Light has not given the Vulgar a greater Disturbance, than that ticking Noise, which is commonly call'd a *Death-Watch*; and I therefore think my self obliged particularly to take notice of it, and satisfy those who are yet ignorant, that it is an *Insect*. The learned Dr. *Derham*, in a Letter to me, mentions two sorts of the *Death-watch*, one is about the Bigness and Shape of a *Louse*, and the other a very small *Insect* made like a *Beetle*: these commonly are found in *July*, in dusty Places, where they are bred and feed. This curious Gentleman observes farther, that they tick only when they are about
to

to generate; he gives us a Cut of the first Kind in its natural Size, and which with the *Microscope* I have copy'd from him; but the other sort I have not been lucky enough to find, tho' there are many of them (as I am inform'd) in the great Library at the Royal Society. See more of this Creature in *Phil. Trans.* N^o 291.

The next kind of *Insect* I shall take notice of is, of that Race which is call'd *Folium Ambulans*, or *walking Leaf*, which I have already treated of in my new *Improvements of Planting and Gardening*; 'tis a Creature which, if we take the Story of it right, partakes both of *Insectal* and *Vegetative* Life, being nourish'd, as I have observ'd, as well by the Juices of the *Tree*, which the Mother *Insect* lays its *Eggs* in, as by its own, which I suppose are so united, that one and the other circulate equally in the Body of the *Insect*, till it self, with the *Leaves* joining to it, drop from the *Tree*, and creep upon the Ground. In the above-named Work I have given Figures of two Kinds of this Creature, which are *East Indians*, and have refer'd to the Cabinets of Dr. *Frederick Ruysch* and Mr. *Vincent of Holland*.

The *Insects* we come now to take notice of, are such as are of the smaller Kinds, *i. e.* those in *Cheese*, *sower Liquors*, *Pepper-water*, *putrified Paste*, &c. The largest of these is the *Cheese-mite*, which however is not big enough to have its Parts distinguish'd by the natural *Eye*, but must be observ'd with a magnifying *Glass* to describe its Appearance. We may remark, by the help of *Glasses*, that this Creature, however minute it is, has all its Parts regularly framed, and its Motion agreeable to larger *Insects*, with *six Legs*. We may likewise be assured of its Generation, like other *Insects*, by the Numbers a few will produce in a little time, and every one of them of the same regular Figure. In *putrified Paste*, we may observe, with the *Eye* only, a Motion, tho' we cannot discern distinctly what Bodies they are that move in it; but if we put the Quantity of a Grain of

Sand of that moving *Paste* into the *Microscope*, and add to it as much *Water*, the fourth *Glass* of Mr. *Wilson's Microscope*, or of those *Glasses* made by Mr. *Scarlett* near St. *Anne's Church Soho*, will shew them to be *Insects* of an *Eel-like Figure*, about an Inch long. In the *Lees* of *Wine*, and upon the *Outsides* of *Wine-Casks*, we find great *Varieties* of living *Creatures*, which are very proper *Subjects* for the *Microscope*; and even the *Mosses* or *Mouldiness* found in such damp *Places* as *Cellars*, and especially where *Wine* is kept, gives us very entertaining *Prospects*. *Vinegar* and *Pepper-water* likewise afford us abundance of *Variety*; but because I have found it a little difficult to bring *Water* and *Pepper* into a right *State* of yielding these *Insects*, I shall take this *Occasion* to advertise my *Reader* how I brought it the *Perfection* I desired; for I don't know any *Author* that has yet given the *Receipt*. About *June* I took a *Pint* of clear *Water*, and put to it five or six whole *Pepper-Corns*, which I exposed in a *Poringer* to the open *Air* about three *Weeks*, I then found great *Numbers* of little *Animalcula* swimming in a small *Drop* of it; but in some *Waters*, where I had put beaten or grownded *Pepper*, I could not discover any *Insects*. We may further remark, that if we put *Hair*, *Leather*, or any part of *Animal Bodies* into *Water*, and let it stand for three *Weeks* or a *Month*, about *June*, *July*, or *August*, we find it fill'd with *Insects* of various *Forms*; but I suppose the several *Kinds*, observable in the several *Waters*, have not their *Original* in those *Waters*, but are severally produced from *Eggs* lay'd there by some *Mother Insects*, that are then in the *Air*, which respectively come to each of them, as to proper *Nests* or *Nurseries* for their *Young*; and I the rather am of this *Opinion*, because if we can keep such *Bodies* as usually produce *Insects* confined by *Coverings* of *Laun*, or such like, we find no living *Creatures* in them. And again, as the *Mother Insects* are of that diminutive *Size*, that they are not to be discern'd without *Microscopes*, it is no wonder they can lay

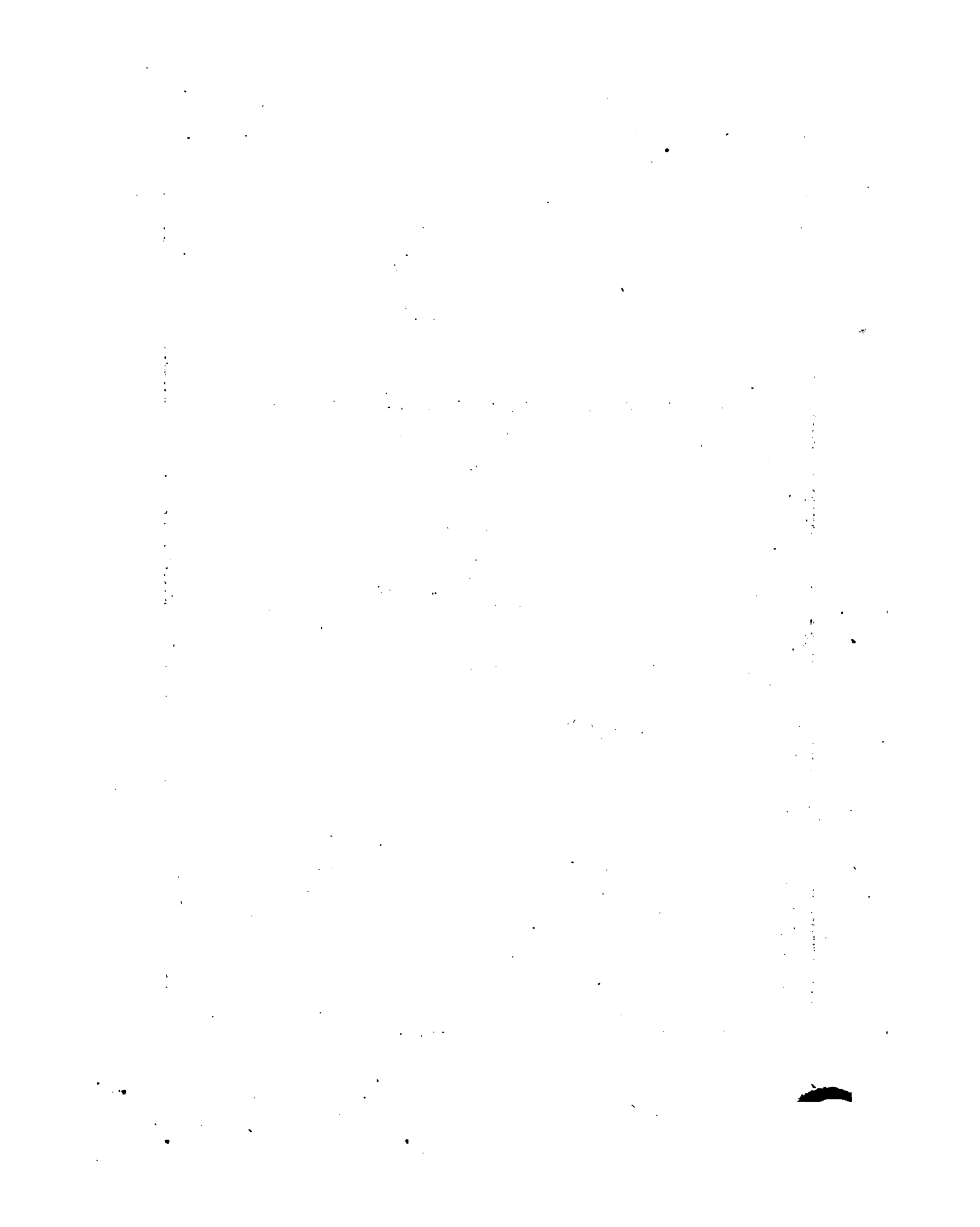


FIG. I.



FIG. II.



FIG. III.



FIG. IV.

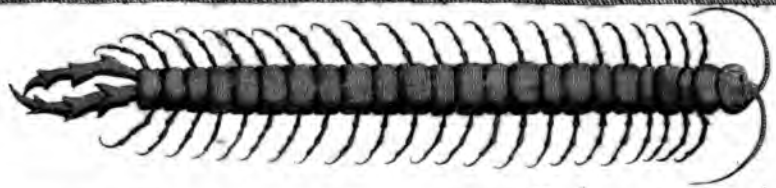
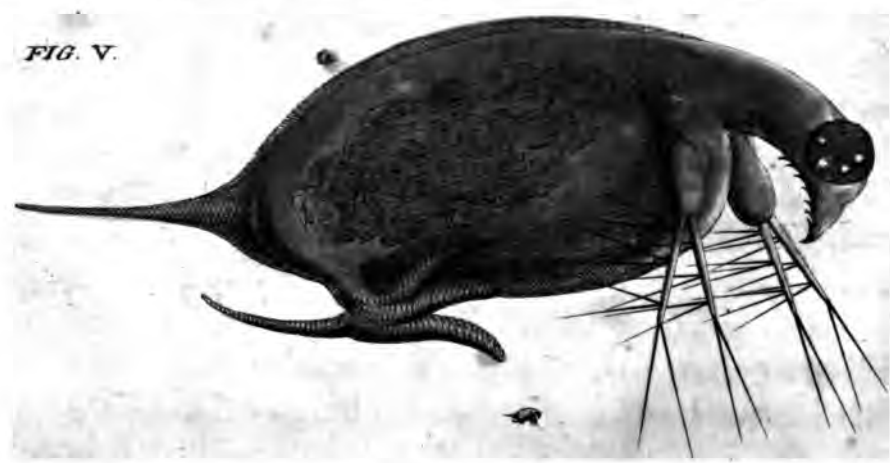


FIG. V.



lay their *Eggs* in those Mixtures without being perceiv'd; and I suppose the Air is full of them, especially in the Summer Months, the smaller sorts serving as Food to the greater; and it may be therefore that Nature has made the smallest Kinds more prolific than the rest.

I come now to conclude this Chapter with some Account of the *Animalcula* in *Semine Masculino*, or such minute Creatures as are found in the *Male Liquor* of living Bodies, which some of the Learned suppose to be the Rudiment or Principle of the *Foetus*. In taking of this *Liquor* from the several Kinds of *Animals*, we find by the *Microscope*, that the *Animalcula* are of different Figures and Bigness, as the *Animals* they were taken from differ in their Parts from one another. And these minute Creatures have so much Life and Spirit in them, that sometimes they remain alive above three Weeks after they are taken from their Parent *Animal*: The different Opinions concerning their Progress into the *Matrix* of the *Female*, see in Dr. *Geoffroy's* Letter in the Chapter of *Quadrupedes*, the Figures of one Kind of them I have delineated in Plate XXV. Fig. II.

Explanation of the Plates relating to this Chapter.

P L A T E XXV.

- Fig. I. *The Bull-Beetle; from the Royal Society.*
- Fig. II. *The Animalcula in Semine Masculino.*
- Fig. III. *The last State of the large Gnat.*
- Fig. IV. *A Centipes; from the West Indies.*
- Fig. V. *A Monoculus found in Thames Water, by the Microscope.*

P L A T E XXVI.

Fig. I. *Shewing the Gradation from the Moth A, by B and C, to the Humble Bee D.*

Fig. II. A: *A Water-Beetle.*
 B: *Cantharis Aquatica.*
 C: *A Water-Scorpion.*
 D: *Cramp Spider.*
 E: *Boat-Fly.*

Fig. III. A: *A Female Glow-Worm.*
 B: *The Male Glow-Worm.*

N. B. *The Contents of this Plate from Mr. Dandridge.*

Fig. IV. *The Insect which blighted the Horse-beans in many Parts of England, Anno 1719; from the Reverend Mr. Lawrence.*

P L A T E XXVII.

Fig. I. A: *The Eggs of the Silk-Worm.*
 B: *The Nympha, or Caterpillar of the same.*
 C: *The Silk-Bag of the same, in which it changes into the Chrysalis D.*
 E: *The Male Moth proceeding from the Chrysalis.*
 F, *the Female Moth proceeding from the same.*

Fig. II. A: *The Nympha, or Caterpillar feeding upon the Nettle, which changes to the Chrysalis B, to the Butterfly C.*

Fig. III. A: *The Death-watch, of its natural Bigness.* B: *The same with the Microscope; from the Reverend Mr. Derham.*

Fig. IV. A: *The Nympha of the Lady Cow.* B: *The Chrysalis of the same: and C: The most perfect State.*

Fig. V. *A Prega Deos; from the East Indies.*

Fig. VI. *An Insect, from Amboina, whose natural Length is eight Inches; taken from the Cabinet of Dr. Ruysh at Amsterdam.*

C H A P.

Fig. I

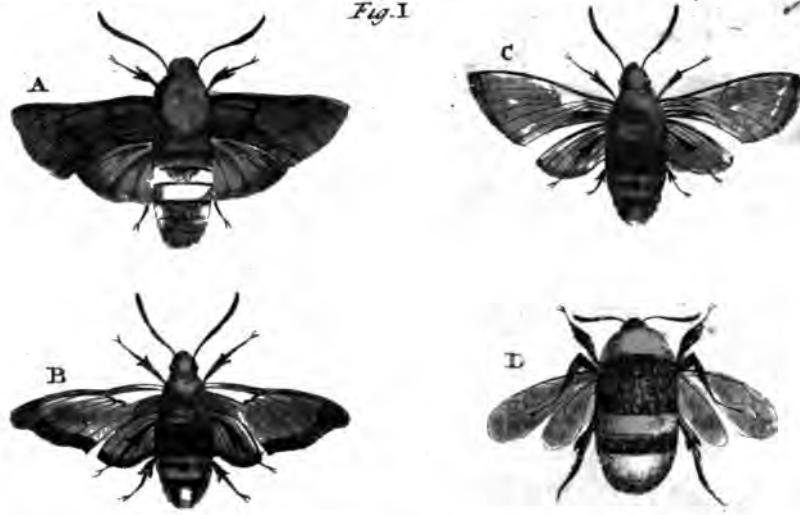


Fig. II

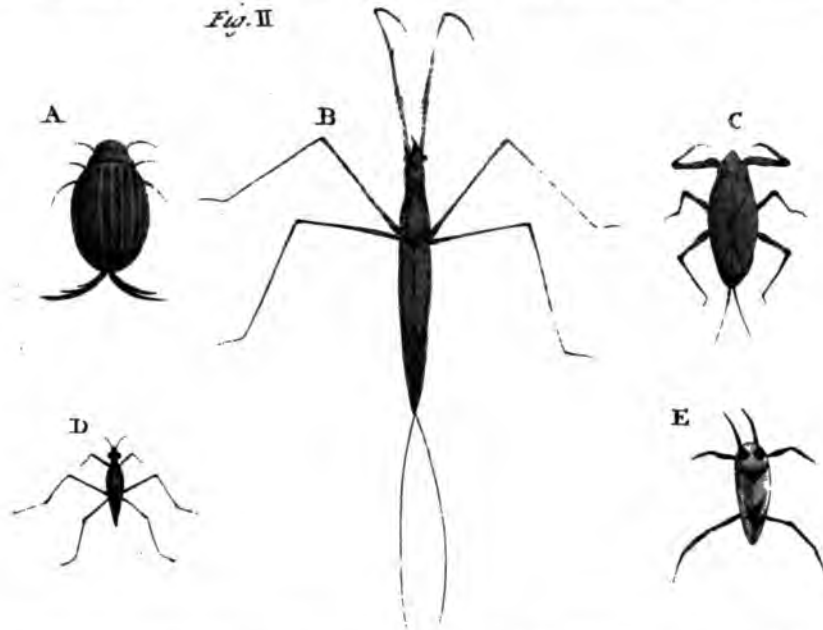


Fig. III

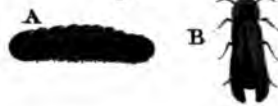
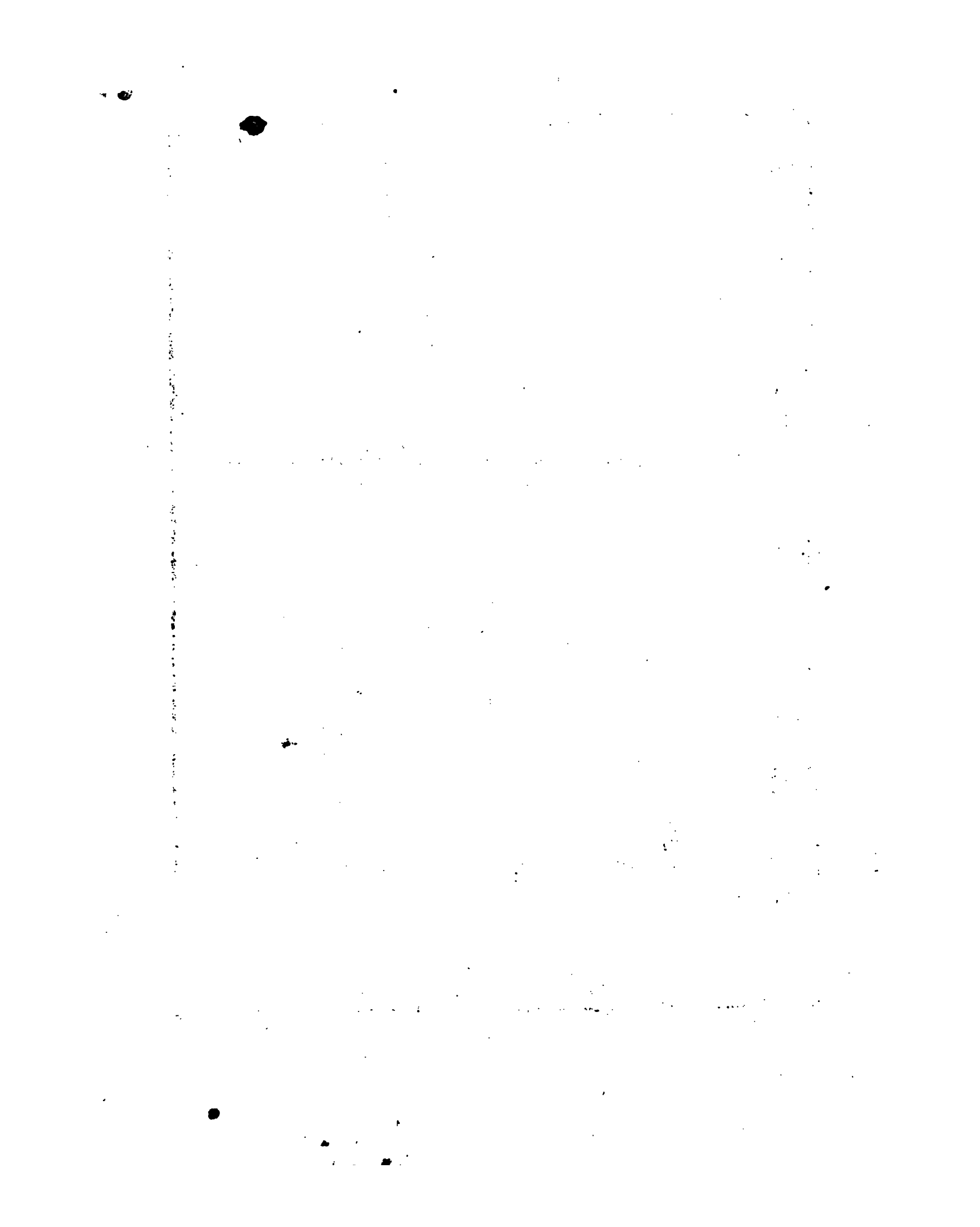
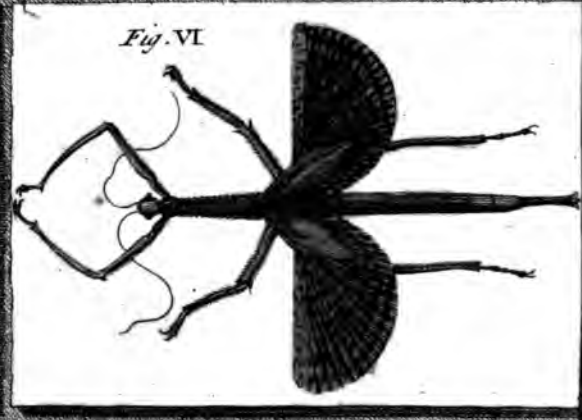
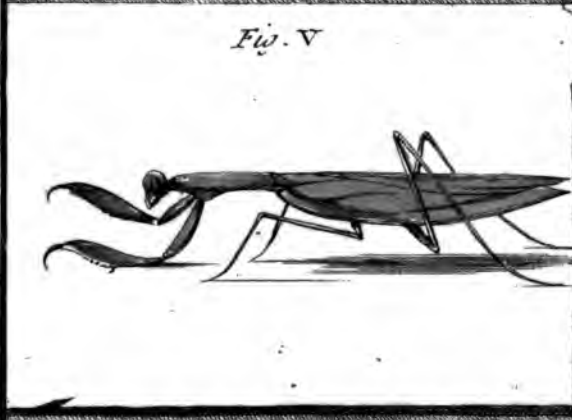
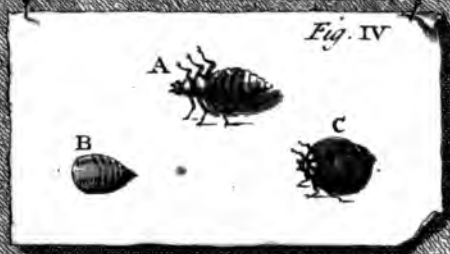
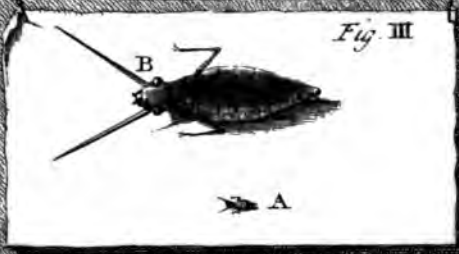
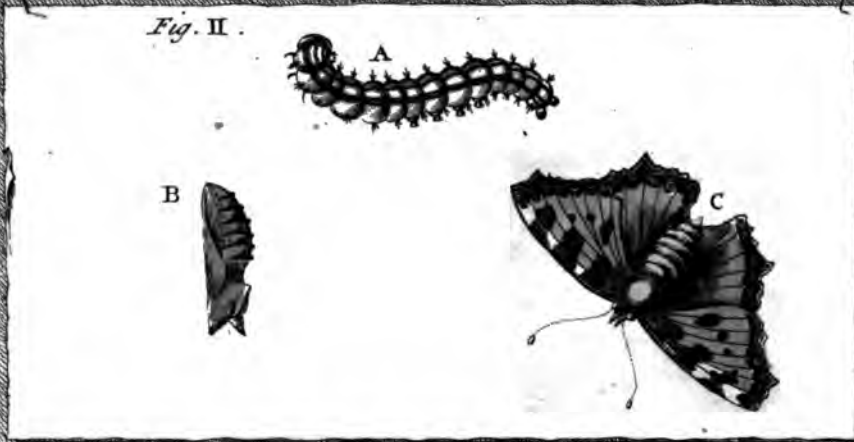
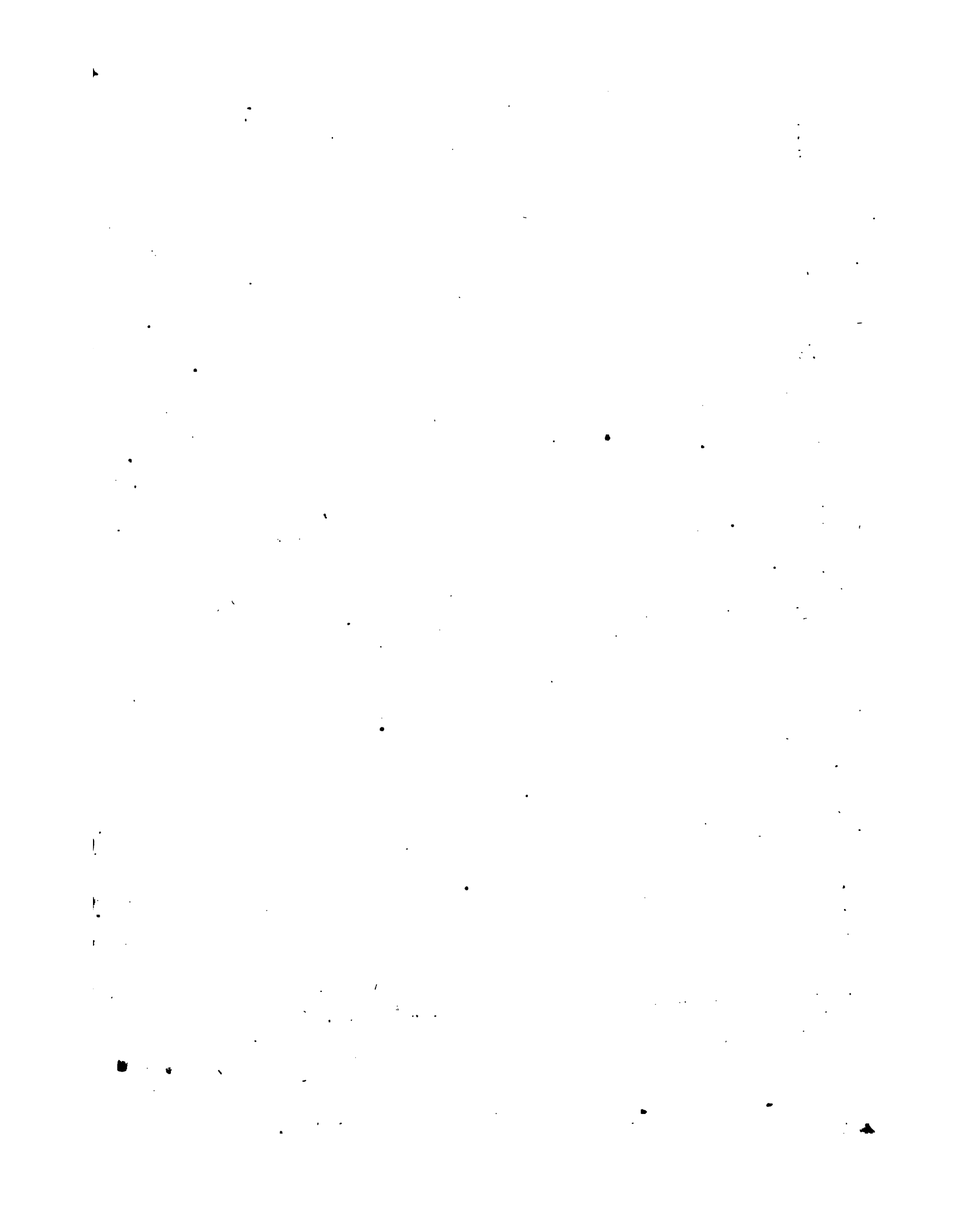


Fig. IV









C H A P. XIV.

Explaining the Use of the foregoing Remarks, with several Observations relating to CLIMATES.

IN the preceding Chapters I have given my Reader a general View of the Remarkables in the Works of the Creation, and have disposed them in such a manner, as may lead us to imagine that all Bodies have some Dependance upon one another; and that every distinct Part of Nature's Works is necessary for the Support of the rest; and that if any one was wanting, all the rest must consequently be out of Order. It seems in this Case, as in that of Numerical Figures, each of which has a Power in it self of filling a certain Space, without which the several Gradations in Numbers cannot be express'd; and was there to be wanting any one of those Figures or Powers, the rest could not maintain a gradual Progression of Numbers, but must frequently make such Breaks and Chasms as would run them into the greatest Confusion and Disproportion.

We observe so exact an Harmony between Natural and Mathematical Proportions, as might give every thinking Man Reason to believe the latter could not have been without the former; or that the Laws or Rules of Mathematicks, as they now are, could not be just, if Nature's Laws were different from what we now observe them to be. In whatever falls under our Observation in Nature's Works, we may remark a constant Regularity, and a just Symetry and Proportion; the *Vegetables* have their *Roots* proportionable to the *Branches* and *Parts* they are to maintain; the *Animals* have their *Stomachs* agreeable to the Quantity of Food necessary for their Support; and even those *Insects* which are of the least regard, have every Part disposed with such a just
Regu-

Regularity and Property, as to bear an Analogy with those in *Animals* of the greatest Esteem. The Frame and Figure of the Parts relating to every *Animal*, bears a right Proportion with the Body it is to move or direct: And the Length of Life in all Bodies is more or less, as any of those Bodies are later or sooner coming to their Perfection of Growth; for we observe, that such Bodies as are most speedy in their Growth, are proportionably short-liv'd, and of small Remain; and so on the contrary. In Musick, there are seven distinct *Tones* or *Notes*, which singly express a Power of *Sound* different from the rest; and when any one of those *Tones* is laid down as a *Ground-work*, the progressive *Tones* from that *Ground-Note* to the *Octave*, which is the Resolve of the *Ground-Note*, declares the *Key*, either by a certain Number of *Semi-tones*, to express Melancholy, in what is call'd a *Flat-Key*; or by a greater Number of *whole Tones*, to make the Expression more brisk or poignant to the Ear, and then is call'd a *Sharp-Key*; but whether the *Key* be *flat* or *sharp*, there is yet a regular Circulation of *Sound*, which is natural to the Ear, and may well enough be compared with the Circulation of Blood in the Bodies of two *Animals* of different Species, which tho' they both enjoy the Benefit of Circulation of Juices, the one is much brisker and more lively than the other.

The Distance between one *whole Note* and another may be divided into very minute Parts; but those who have to do with imperfect Instruments, such as *Organs*, *Harpsicords*, &c. content themselves only with *Semi-tones* and *Quarter Notes*, in order to keep a tolerable Harmony in every *Key*; but a nice *Ear* may easily discover their Imperfection, especially when they are struck against a *Master Note*. In perfect Instruments, such as the *Violin*, &c. every *Key* may be order'd by the Artist who plays upon it, to express any *Sound* with so great Exactness, that the *Ear* cannot discover the least Disorder or Imperfection of the

the Harmony, the Justness of which may be compared to a healthful Body; the Imperfection of the other to a Body distemper'd, where the Circulation is not just and regular; so we may learn, that where there is a familiar Gradation without Breaks, a thing is natural, but otherwise unnatural.

To suppose that heavy Bodies can be rais'd on a sudden, with the same Certainty that we could move them by gentle Degrees, would make us guilty of an Error. The *Jack*, the *Lever*, the *Wedge*, and such Mechanick Powers, will, by gentle Operation, perform, what the greatest Strength cannot perform on a sudden. A Man might jump down a Precipice and end his Life; but he might take time, and walk perhaps a Mile or two, and gain the Bottom with Safety; 'tis natural therefore to go Step by Step. The Case is the same in *Animal* Bodies, but most remarkable in the Human Race, where, in Health, the Beats of the Pulse agree with the Vibrations of a *Pendulum*; but were we to provoke that Natural Course of the Blood to a quicker Motion, by invigorating Diet, should we not find the Body and the Senses indisposed, and even sometimes by Violence rob the several Parts of their natural Functions, and thereby occasion Death? Were we to examine the Circulation of *Liquors* in the several Kinds of Bodies animated, we find the *Squirrel* and some others to have naturally a much quicker Pulsation than Mankind; and the *Snail*, &c. have a Circulation of Juices much slower; but must we therefore conclude, that a Man is in Health because his Pulse keeps time, either with that of an healthful *Squirrel* or *Snail*? The Parts of every distinct Creature are so order'd by Nature, as to receive, in a certain Capacity, the *Liquors* flowing through them; but were those *Liquors* to move either quicker or slower than Nature appointed, in each respective Body, the Body they moved in would be distemper'd.

Heat and Cold are comparative Terms. Fire we say is hot, and Ice is cold; but we say that Water is cold, and the Weather at *Midsummer* is hot; but this Heat, or
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this Cold have their Degrees as much as Light and Darknes, or White and Black, or any other Colours. To say that a thing is *Red*, is not to express what Colour properly it is of; there is the *Carmin*, the *Lake*, the *Vermilion*, and *Red Leads*, which shew us there are many degrees of Colour. Again, the Degrees of Heat are innumerable; one will melt *Gold*, another *Silver*, another *Copper*, another *Lead* and *Tinn*, another *Rosin* and *Wax*, and a less than that *Ice*. And now we come to say that *Water* is harden'd into *Ice* by *Cold*; and, as some say, *Chrystaline* Bodies are consolidated by a continued extreme *Cold*; but the hardening of *Water* into *Ice* happens only from a less Share of *Heat*, as the liquifying of *Wax* and some *Metals* is caused by a greater; so that *Cold* is only a less Share of *Heat*, and so the contrary.

The Great and the Less have their gradual Differences. A *Grain* of *Sand*, and the *Terraqueous Globe*, one may suppose at a vast Distance from one another, with respect of Magnitude; but alas, were we to make Comparison between the *Globe* of *Earth* and the other *Planets*, we should find a Difference almost as extensive as between the *Grain* of *Sand* and our *Globe*; but between these Points of Magnitude there is room in Thought for innumerable Distinctions; so is it in the Appointment of Numbers, they seem capable of infinite Division and Encrease. The *Tones* or *Notes* of Musick are as divisible. The gradual Encrease of Mechanick Powers is as extensive, and the Vegetation of *Plants* is as gradual, as well as the Life and Growth of *Animals*. 'Tis therefore in this Introduction to Natural History I have supposed a *Scale of Life*, or a Chain of created Beings; for if our Reason tells us we ought to move gradually, there is certainly a Gradation in Nature, and therefore that gradual Motion is natural and reasonable, and whatever is not so is contrary to Nature and Reason; and I don't know a better way of bringing the unlearned to a right Judgment of Things, than by giving them a general

ral View of Nature's Works; which at the same time may lead them into the way of Reason, and shew them the Wisdom of the CREATOR.

All our Senses are Witnesses of these Gradations in Nature, by which we are taught to act with Gentleness and Deliberation in such Things as are to be durable; for whatever is too hastily gone about, or is forced to greater Speed than Nature appoints, must inevitably perish before its due time; and it is from a just Observance of such progressive Methods as Nature takes in the ordering and directing her Works, that our Reason is guided truly to our Advantage.

From Considerations of this kind we may learn how ridiculous it would be to suppose, that because a *Plant* cultivated in the torrid Zone requir'd a greater *Heat* than we enjoy in our *Climate* to support it in a due State of Health, that therefore the Heat of a Furnace would give it a quicker Vegetation; or to conclude, when we had kill'd a *Plant* or an *Animal* by an extraordinary Warmth, that therefore Nature directed it should have none at all. There are certain Degrees to be chosen, agreeable to those appointed by Nature, for the Support of each respective *Plant* and *Animal*; nor ought we to suppose, that because we find a Gardener raises a prosperous Crop in one place, we may have the same Success in another, without thinking reasonably upon the Difference of the Soil or Situation: But yet have I known many Instances of Men, who have been Sufferers, by acting without Understanding in Cases of this Nature. Some who have been enrich'd by a *Clay*, have been undone by following the same Rules upon a *Sand*; others have so far out-done *Natural Heat*, that they have consumed their Gardens, and destroy'd all they had, without regarding that Nature has her Laws, which must be obey'd, and that she acts with Gentleness, and will not be forced out of her Way. Thus it appears that an Art is only the true Knowledge of Nature, and that those who do not really

know the Natural Foundation of what they profess, are not Artists.

The more particular Use of this Scheme to Gardeners is, by directing them to consider, that as every distinct *Animal* has its *Climate* and *Food* natural to it, so has every *Plant* an *Exposure*, *Temper* of *Air*, and *Soil*, proper to nourish and maintain it in a right State of Health: And again, as we find some *Animals* to delight in the *Waters*, some in open *Air*, and some under the *Earth*; so are there *Plants* likewise that have their respective Appointments in the *Waters*, as the *Lens Palustris*, or *Duck-meat*; and in the *Air* as most *succulent Plants*; and even under the *Earth*, as the *Truffle*; so in all Plantations we make, we ought to observe what *Element*, *Situation*, and *Soil*, relates to each, if we would be sure of Success.

To judge rightly of the Method of treating *Plants* brought to us from several Parts of the World, I consider three Things. First, The *Soil* of the Country they grow in, which I would imitate as near as possible. Secondly, The Time of the *Spring* in the Country they are natural to, and as near as may be the Degree of *Heat* in that Time of *Spring*; for as every *Plant* has its appointed Times of Rest and Growth, it would be unnatural to force its Growth, when Nature ordain'd its Repose, or to abandon it to Repose, when it should be assisted by a Warmth agreeable to its own Country *Spring*.

To know the Time of *Spring* agreeable to every *Plant*, is first to learn the Latitude of the Country it grew in, and in the next place to consider the Degree of *Heat* natural to that *Climate* in the Time of its *Spring*. To judge of the Time of the *Spring* in every Country, is to observe first in what *Zone* it lies, whether in the *Torrid Zone* (that is) between the *Tropics*, or in the *Temperate Zones* (that is) from each *Tropic* to the nearest Bounds of the *Frigid Zones*, or from the *Polar Circles* even to the *Poles* themselves.

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The *Plants* which grow between the *Equinoctial Line* and the *Tropic of Cancer*, or to the Northward (*i. e.*) towards us, we suppose to have their *Spring* as soon as our Days lengthen: And as the *Sun* comes towards us more and more, all the Places between that *Line* and the *Tropic* are gradually enliven'd with *Spring*. At the same time, while the *Sun* moves this way to its *Boundary* or *Tropic*, which is about twenty three Degrees North Latitude, the Influence of it has its Operations on every thing gradually from the *Tropic* to the *Polar Circle*, and from that to the *Pole* it self; so that if we judge of the Latitudes, as they are gradually placed in the *Maps*, and the Times and Degrees of *Heat* progressively moving through them, we cannot fail of giving every *Plant*, from any part on this side the *Line*, its Force or Warmth at the right Season; and so we must maintain a due Regard to such *Plants* as are Natives of those Countries on the other side the *Line*. When the *Sun* begins to leave us, their *Spring* is then coming forward, and every Day encreases as much that way, as we on the North Side of the *Line* decline into *Winter*; so that whatever *Plants* we have from thence, we ought to help at that time, as we would our own in our own *Spring*.

We are moreover to remark, that as the *Sun's* Motion and great Influence is between the *Tropics*; and that every Year its Motion is from South to North, and back again; so that Motion will produce two *Springs* every Year in each of the Countries it passes over, which *Springs* we may judge of, by enquiring into the *Sun's* Course, which a common *Almanack* will shew us; and then allowing about six Weeks for the *Sun's* Progress, before it can be directly over the Place we pitch upon, I suppose that will be the Time of *Spring* in that Country; for when the *Sun's* Power is most violent in any Place, we find all *Plants* have finish'd their *Spring* Shoot, as we observe in *England* at the Time of our *Midsummer*, when the *Sun* is nearest to us. In the *Temperate Zones*, such as we have the Happiness to enjoy, tho' the *Sun's* Influence

Influence is more moderate, yet we may observe that the greatest Share of *Heat* only serves to ripen our Fruits; but 'tis the gentle Warmth gradually encreasing which makes our *Plants* vegetate, such as the Warmth in *April*.

When the *Spring-Shoot* is perfected, and the great *Summer-Heat* is over, Nature begins to make a second *Shoot*; but that *Shoot* is seldom of any great Consequence in our Country; the *Sun's Heat* declines, when our *Plants* want it to encrease, and the Attempt of Vegetation proves vain. I am of Opinion, were we then to give those shooting *Plants* a convenient *Shelter*, and an additional *Heat*, regulated by a *Thermometer*, so that it should be equal to that in the Month of *April*, we might even bring them to bear *Fruit* in the *Autumn* Season. I have known some *Trees* which, without any help, have ripen'd some few *Fruit* of the second *Spring*. 'Tis common enough in *Strawberries*, *Rasberries*, and *Cherry-trees*, especially if the *Blossoms* of the first *Spring* have been taken off at their first Appearance.

When we have consider'd the Time of *Spring* in the several Countries of the *Earth*, where we receive *Plants* from, we are next to enquire the Degrees of *Heat* in each of those Places at the Time of their respective *Springs*, which we must imitate as near as possible; and I observe, that our *Midsummer Heat* is powerful enough to maintain any *Plant* brought us from between the *Tropics*; therefore, as we have it in our Power to give that degree of *Heat* at any time of the Year, by means of Fire, we may keep any *Plant* even from under the *Line* in our Conservatories, regulated by a *Thermometer* at our *Midsummer* degree of *Heat*, which I suppose will agree well enough with the *Spring Heats* in those Countries lying between the *Tropics*; and at the same time I would have an *Hygrometer* in the same Stove or Conservatory, by which we might regulate the over Moisture or Damps in the Air of the House.

I find that in *England* our Air is generally so temperate, or the Passage from the *Heat* to the *Cold* is so gradual, that *Plants* which naturally grow eight or nine Degrees more South than we are, will grow here without any Shelter; but indeed they have this Advantage, that the Time of their Natural *Spring*, or awaking from their Rest, is but a little different from the Season of our *Spring*; so that when Nature appoints them to make their Shoot, the *Sun* is coming towards us, and backs them in their Attempt.

In my *Kalendar of Gardening* I have given a Design of a Greenhouse or Repository for *exotick Plants*; but for the Preservation of the most tender Kinds, such as grow near the *Line*, there is no one does so well as that contrived by the curious Monsieur *Le Cour* of *Leyden*, for the Production of that excellent *Fruit*, call'd the *Ananas* or *Pine-Apple*, from whose Model there are two or three now built in *England*.

But I think I have said enough to inform my Reader how necessary it is to observe the Laws of Nature in the Preservation of created Bodies, tho' I am not insensible that even the Contemplation of one created Body alone would afford Matter enough for a Book much larger than this Volume; but my Business is rather to give a general View of Things, than to enter upon Particulars with too much Freedom; and I chuse to leave the Enquiry into the more nice Parts to the Curious, who have Leisure and Opportunity to observe them.

By way of Conclusion to this Chapter, I am to take notice of some Particulars relating to Mankind, as I promis'd in my Chapter of *Quadrupedes*; for Man, altho' he is Lord of all, and has a Power of Ordering and Governing all living Creatures, which relate to our *Globe*, yet has he many Particulars in his Frame, which bear Analogy with the Parts of those Creatures he is ordain'd to govern. The Harmony which Nature maintains in the Generation and Production of *Quadrupedes*, is not contradicted

in HIM. The Functions of several Parts in Brutes direct them to perform what the same Parts would do in Mankind, was he not endow'd with Reason to guide him in his Actions, and overrule what is brutal in him. But this is a Matter which relates more particularly to those who make it their Business to consult the Health and Welfare of Men, rather than to Natural History, which is my present Subject. I shall content my self with observing only some remarkable Particulars, which are not commonly taken notice of in Mankind.

The Longings in Women, and the Marking of Children, are Subjects which have occasion'd Disputes among the Learned; but I don't find either of those Cases yet determin'd, so that I cannot well omit a Conjecture or two of mine relating to those Subjects. I suppose, when a Woman is pregnant, there is a regular Circulation of Juices through the Bodies of both the *Mother* and the *Fœtus*, admitting only that the Parts of the *Fœtus* subsist or are supported by such fine Juices as we may say are distill'd from the Blood of the *Mother*; for the Parts fully grown are undoubtedly more capable of giving Passage to more gross Juices than those which are in *Embryo*, and in such a minute Body; and in the *Fœtus* must be as fine as a subtle Vapour, almost equal to those Spirits which nourish the *Brain* of a full-grown Body.

The *Fœtus* has its *Head* first form'd, and that, as well as all the other Parts, is regularly supply'd with Juices from the several Parts of the *Mother*, as they are analogous to one another; therefore, I suppose, as the *Bram*, both of the *Mother* and *Fœtus*, have an immediate Communication with one another, so I imagine the extraordinary Desire of the *Mother* has so immediate an Effect on the *Brain* of the *Fœtus*, that it becomes distemper'd, and consequently must affect the *Bram* of the pregnant Woman, and so both are out of order.

Again, the pregnant Woman, by touching any Part of her Body, when a strong Desire of any thing reigns over her, must have

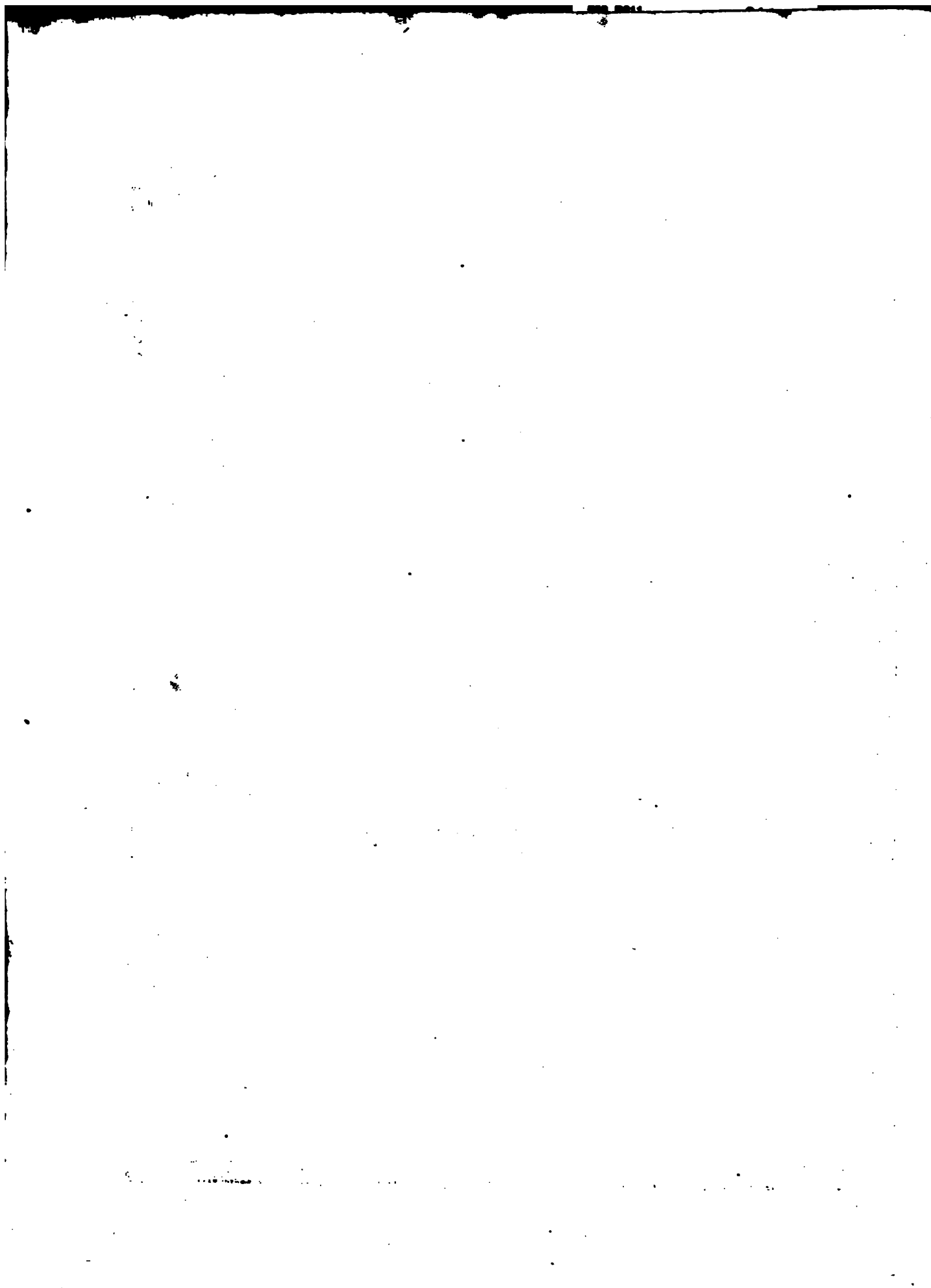


Fig. III.



Fig. II.



Fig. I.



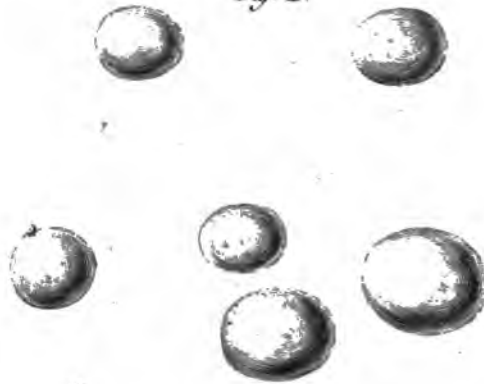
Fig. III.



Fig. II.



Fig. I.



have an extraordinary Power over the same Part of the *Foetus*, and especially because things so small and flexible will sooner take an Impression than others that are perfected; but this by way of Hint to the Learned. I proceed to take notice of the several Kinds of Men, whose Difference is remarkable.

We find five Sorts of Men; the *White Men*, which are *Europeans*, that have *Beards*; and a sort of *White Men* in *America* (as I am told) that only differ from us in having no *Beards*. The third sort are the *Malatoes*, which have their *Skins* almost of a *Copper Colour*, *small Eyes*, and *strait black Hair*. The fourth Kind are the *Blacks*, which have *strait black Hair*: And the fifth are the *Blacks* of *Guiney*, whose *Hair* is *curl'd*, like the *Wool* of a *Sheep*, which Difference is enough to shew us their Distinctions; for, as to their Knowledge, I suppose there would not be any great Difference, if it was possible they could be all born of the same Parents, and have the same Education, they would vary no more in Understanding than Children of the same House.

Explanation of the Figures relating to this Chapter.

P L A T E XVIII.

Fig. I. *The Eggs taken from the Ovary of a Woman; by Dr. Douglass.*

Fig. II. *An Human Foetus before Quickening; taken from the Royal Society.*

Fig. III. *An Human Foetus after Quickening; taken from the Royal Society.*

P L A T E XIX.

Fig. I. *A Skeleton of a Man, whereby the Difference in the Osteology in the Man and other Creatures, may be observ'd.*

Fig. II. *The Skeleton of a Monkey, shewing the Difference between that and Mankind.*

C H A P. XV.

An Account of such Lands in England as are stiled
BARREN, *with some Propositions tending to their*
Improvement, and some Remarks relating to **FISH-**
PONDS.

IN my *New Improvements of Planting, &c.* I have endeavour'd to excite our *English* Nobility to planting of Timber, as well for the Use of their own Families, as for the publick Good; and since I find those Papers have not been disagreeable to the Publick, I am the more ready to publish what I have since observ'd in the Culture of profitable *Trees*, and the Method of Improving what we now call *Barren Lands*. I have often view'd our *desolate Forests*, and *barren Plains* with an Eye of Pity, considering how much we were at the same time beholden to distant Nations for those Commodities, which might with Ease be cultivated in our own Country, and which might turn to great Profit to our selves, and secure us from the Assaults of presumptuous Neighbours.

In my Travels about *England*, I observ'd that we have three sorts of Soil, which generally are counted unprofitable, such as *Heath Ground*, *Chalky Hills* and *Plains*, and that which affords only what is call'd *dead Sand*. Some of the *Forests* indeed yield
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Fig. I.



Fig. II.





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good profitable *Land* for *Corn* and *Pasture*, and have formerly born valuable Burthens of *Trees*; as have also some *Grounds* belonging to private Gentlemen, from whence, upon Emergencies, has been reap'd considerable Crops of *Timber*, whose Price has even over-ballanced the Worth of the *Ground* it grew upon. And we have many late Instances of Estates which have been sold, where, in a few Years afterwards, the *Timber* growing upon them was sold for more Money than was given for the whole Purchase of the *Land*. In my former Works upon this Head, I have rated *Land* for *Timber* at five Shillings an Acre; but the *Ground* I shall treat of in this Chapter is such, as is in very little Esteem. The first I shall take notice of are the *Heaths* in *England*, which at present scarcely yield Food enough for *Sheep*, and are of no other Use. This sort of *Land*, which is generally sandy, and in which commonly we find abundance of *morass Ground*, I advise to be cultivated for the propagating of *Firr-Trees*, which are of very quick Growth, useful, and agree well with such *Land*. We have some Instances of this sort of *Land* cultivated in this manner in our own Nation; but in *Germany*, and some of the North Parts of *Europe*, we find whole *Forests* of *Firrs* growing in this kind of *Soil*. At the Earl of *Alresford's*, near *Guilford* in *Surrey*, we have an Example of the good Thriving of these *Trees* upon a *Hill* of common *White Sand*, in which one could hardly expect the least *Vegetable Quality*; and, if I am informed right, the *Trees* now growing at that Place have not been planted there quite thirty Years, altho' they are now about forty Foot high; but it is to be observed, that they are hardly six Foot asunder, which may be the Occasion of their extraordinary Heighth, and the Clearness of their *Stems*, without Knots. The Experience I have had of this *Tree*, especially the *Scotch Firr*, teaches me, that it thrives better raised from *Seed* upon the Spot where it is designed to remain, than if it is transplanted.

To make a Seminary of these *Trees*, we gather the *Cones* or *Fruit* of them in *September*, even while their *Rind* partakes yet of a *Green* Colour; for those *Cones* which are already cracked and opened produce little or no good *Seed*. The *Cones* being thus gathered, we lay them in a dry Place during the Winter, and about *February* either expose them to the Sun till they crack and open, or else put them in some Vessel into an Oven after the great Heat is gone off, by either of these ways we come at the *Seed* without difficulty, as I have tried with good Success; tho' some have been apt to suspect, that those *Cones* and *Seeds* which are opened by the Heat of an Oven, would be too much dried to vegetate or spring in the *Ground*: When these *Seeds* are well cleaned, we sow them thin in Beds, covering them about half an Inch deep with fine Earth, and in a Month's time they come up; but we must have great Care at their first Appearance to preserve them from *Snails*, which are their greatest Enemies: The same Summer they shoot hardly more than an Inch, and as their *Roots* lie very near the Surface, it is advisable to sift *Sand* over the Beds near half an Inch thick, about *September*, to keep them steady, and prevent the Frosts from turning them out of the *Ground*. The second Year they make *Plants* of about four Inches high, and if they were to remain in the same Bed the third Year, they would be near a Foot taller; but I hold it much better, if any of them are to be removed, that it should be done when they are two Years old, and even then with extraordinary Care, laying them in a Barrow or Case of Earth, to be transported to the Place appointed for the great Plantation; and observe, that we do not take them out of this Earth, till the very Instant, if possible, that we are to place them in the Station where they are ever after to remain; for a little Air dries and shrinks the Coat of their *Roots*, and their *Parenchymous* Parts; so that they remain for a time without the Power of Growth, and perhaps rot or grow distempered by a Stagnation of the Juices. In
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this Plantation I would not advise them to be set more than six Foot a-part, which would be a means, as I have observed before, of their growing strait and tall, unless indeed we would run the Hazard of transplanting some of them a second time, and then the Distance between them need not be above three Foot, which would yet contribute so much the more to their aspiring and upright Growth, during their juvenile State; they might remain in this manner about five or six Years, and then it would be high time to draw every other *Tree* to make room for the rest. The Method which has been used for transplanting *Firr-Trees* of this Age, and even some Years beyond it, with good Success, was invented and first practised by the honourable *James Johnston* of *Twittenham*, Esq; who about *Midsummer* transplanted some of these *Trees* above twenty Foot high, in a Preparation of *Earth* and *Water*, of the Consistency of a thin *Mud*, filling it up with fine *Earth*, till the *Root* of the *Tree* was firmly settled in it, by this Means the *Trees*, so planted, had made Shoots on their Tops above a Foot long the following Year, before the others which remained in the Nursery had even began to shoot.

In my Chapter of *Vegetables* I have taken notice of a new invented Method of transplanting *Trees* with Safety, by means of a *Vegetable Mummy*, or Compositions of *Pitch*, *Bees-Wax*, *Turpentine*, and such like; and I believe it would be of no small Use in this Case, especially if we were to transport *Trees* to any great distance. The anointing the *Roots* with such Preparations, and especially those Parts where they have been cut or wounded, would keep them from drying, or shrinking up by the Air or Sun, and even contribute somewhat to their Growth. For the *Firr*, indeed, I rather recommend the anointing the *Roots* with *Turpentine* alone, or else mix'd with *Tallow*, which might easily be done with a Brush when it was warm; for the *Turpentine* I suppose cannot fail of giving some Nourishment to the *Tree* which naturally produces it. And the *Fat* of *Animals*

is generally allow'd to assist *Vegetation*, as I have observ'd in my Chapter of *Vegetables*, where I recommend the Use of *Soap*, &c. to anoint the *Roots* of *Vegetables*, which see.

The *Scotch Firr* and *Pinafter* are what I chiefly would advise to be planted for *Timber*, in *Sandy* and *Heathy Ground*, as they are both able to maintain themselves in Variety of Seasons. I have seen of both these Kinds, that have yielded profitable *Timber* for *Plank* or *Boards* in forty Years from the setting, as the People now living have assured me, that saw them planted and raised from *Seeds*. A Gentleman of *Devonshire* has now many of them growing upon a *red Rock*, where they thrive exceedingly; so that the *Hills* in *Darbyshire*, and such others as are Rocky like them, need not despair of bearing one time or other this profitable Burden. But least forty Years should be counted too much time to wait, without receiving any Advantage, let us consider the *Ground* was before the Plantation good for little or nothing; and in half the mention'd Space, the *Plants* which may be drawn out to thin the rest will be fit for Scaffolding, or some other Uses; and all this time the growing *Trees* are encreasing in their Value, without any Expencc or Labour, more than the first Charge.

But as *Heath Ground* is the Soil I propose for such Plantations, and is for the most part in Common, it will be difficult to enclose it. I think, however, the best Method to overcome that Difficulty, would be to summon the Poor of the Parish, who have chiefly the Right of Commoning, and parcel such *Land* in as many Lots as there are Persons who can justly claim a Right to it; and then the Choice among them, of the respective Parcels of *Land*, to be made by balloting, or else let them chuse according to their Seniority, or the Length of Time that each of them or their Families have been Inhabitants of the Parish; by this Means every one of these poor People would find matter of Employment, and become Possessors of *Land*, which they might

might justly call their own, and thereby have Encouragement to cultivate and improve it: These People still being tributary to the Lord of the Manor, in proportion to the Value of such Lands as they hold, and to be obliged also to plant a certain Number of such *Trees* for *Timber* as the *Land* will best nourish. 'Tis my Opinion, that many of our Poor, which at present are troublesome and expensive, may by this Method be rendred useful to the Publick, and live in a contented State, enjoying every Man his own Right, without Encroachment from his Neighbours, or being subject, as the Commoners now are, to have the Benefit run only into a few Hands, while perhaps those who have the greatest Right, have hardly Pasture enough for half a Dozen *Sheep*, when others find Subsistence for two or three hundred.

Another way, which might tend to the Improvement and propagating of *Timber*, would be by obligating every Tenant at the renewing of his Lease, to plant certain Numbers of *Trees* at his own Expence. Where any considerable Plantation happens to be made, I would advise a *Stone* to be set up, with an Inscription, intimating the Year, the Season, and by whom planted, that it might be an Instruction to future Ages how long such *Trees* have been growing, to produce the Sum they may then be sold for, and inform the Possessor of the Person's Name, who so wisely had the Foresight to provide for him.

The other sort of *Ground*, which next falls under my Consideration, is the *Chalk*, such as we observe, for the most part, on *Salisbury Plain*, and the waste Grounds about *New-Market*; and I much wonder, considering the great Scarcity of *Timber* and Fire Wood in those Countries, that no one has yet began any Plantation thereabouts, especially since we have so many Instances of *Hills* and *Lands* of the same kind of *Chalk* in *Berkshire*, *Oxfordshire*, *Buckinghamshire*, &c. which are cover'd with stately *Trees*, as well for *Timber* as Fire Wood. We there
find

find the *Beech* is natural to that kind of Soil; and in some Places the *English Chesnut* thrives pretty well, and the *Oak* indifferently; but the *Walnut* rejoices in that Soil, if it has any tolerable Shelter. I would recommend therefore to such Gentlemen as have Estates about *Salisbury* and *New-Market*, to take the *Hills* and *Chalky Grounds* of *Berkshire*, &c. for their Example, and cultivate their *Lands*, which are of the same kind, after the same manner; so that in time they might save the Expence and Trouble which they are now at, in sending many Miles for their *Firing* and *Timber*.

The *Beech*, which is a Lover of this Soil, grows much quicker in it than in some *Lands* which are counted much richer, and is raised from the *Mast* without any difficulty, carrying this Conveniency along with it, that the *Seed* does not come up till the second Year; so that upon the first plowing of the *Ground* we may sow the *Beech-mast*, and some kind of *Grain* at the same time, and reap a profitable Crop of *Corn* before the young *Beech* appears, to bear the Expence we have been at in laying up the *Ground*. In twelve or fourteen Years we may begin to reap some Advantage from this new *Wood*, by cutting and thinning such of it as is fit for *Firing*. If we had a hundred Acres planted in this manner, we might cut about an eighth part at one time, and at that rate have a continued Supply from Year to Year; the first growing up by that time we have cut the last; and the last renewing it self again by that time the other seven Parcels have had their second Cutting.

The *English Chesnut* is likewise a very profitable *Tree*; and tho' I have already mention'd it in my *New Improvements of Planting*, &c. yet I cannot help taking notice of the extraordinary Bulk that *Tree* will grow to. Mr. *Greening*, a very ingenious Nursery Man at *Brentford*, tells me, that at the Seat of the Lord *Ducie* at *Tartworth* in *Gloucestershire*, there is now growing an *English Chesnut*, which he measured, and found the
Girt

Girt fifty one Foot about, six Foot above Ground; this *Tree* divides it self at the *Crown* into three *Limbs*, one of which he measured twenty eight Foot and a half in the *Girt*, five Foot above the *Crown* of the *Tree*, which extraordinary Measure of the *Limb* only, is almost equal to the biggest *Oak* in *England*. He observed that the *Soil* was a soft *Clay*, somewhat *Loomy*, and the *Situation* on the North-West Side of a *Hill*: This *Tree*, he tells me, was mentioned in a Book dedicated to King *John*, and was then stiled the *Great* or *Old Chestnut Tree* at *Tartworth*; so that it is supposed it must be now above a thousand Years old. At the same *Seat*, near the Place where this wonderful *Tree* now grows, my Lord *Ducie* told him he lately cut down an *Elm*, out of whose *Limbs* were made a hundred Pair of Stocks for Cart-Wheels, and whose *Body* alone was sold for two and twenty *Guineas* upon the Spot; from whence we may learn how much a *Loomy Soil* contributes to the Growth of *Trees* of this sort.

In *Marsby wet Grounds* the *Osier*, *Alder*, and *Arbeel*, turn to good Account; and may every one of them be raised from *Cuttings*, or *Truncheons* set in the *Ground*, (as I have directed in my Book of Gardening) even tho' it be covered two or three Foot deep with *Water*; especially the *Osier* and the *Alder* would in time, by the matting or entangling of their *Roots*, and continued Fall of their *Leaves*, bring it to solid *Ground*; but *Water* in some Cases is as profitable as the *Land* it self, as I shall observe by and by; in the mean time let me advise, that where *Banks* are necessary to keep *Land* from the overflowing of adjacent *Rivers* or *Lakes*, there is no way of making them so solid and lasting, as by backing them well with *Stakes* of *Willows*, which strike *Root* without any Trouble, and intermix with one another in such a manner, that in a few Years only they become as one *Body*.

But I come now to speak of *Fish-Ponds*, and to mention some Observations concerning the Number of *Fish*, which a certain Quantity of *Water* will maintain. It has been observed, that every kind of *Fish* requires a certain Depth of *Water* to maintain it self in; the smaller sorts delighting and thriving in shallower *Waters* than the greater; and these *Waters* are more or less nourishing to some *Fish*, as they pass through different *Strata*, or Beds of *Earth*, every kind of *Earth* giving its *Figure* to the *Waters* passing through it, or joining with it. The most nourishing *Waters* for *Carp*, are such as are found in *Heatby Grounds*, which are commonly of a *Sandy Soil*; and if it is possible to chuse the Situation of a *Pond*, it is counted much better to have it near the bottom of *Hills*, that upon the Fall of great Rains may wash down *Insects*, and other nourishable Matter into it; and if it could be contrived, the *Water* should be always current through it; where this happens, the same Fund of *Water* will maintain one third more of *Fish* than it would do, if it was only a still *Water*. In the making of a *Pond*, we ought to contrive, that it may have all degrees of Depth as far as six Foot; for if the *Fish* happen to breed in it, the young *Fry* or *Spawn* must have shallow *Water* to live and swim in; and the *Spawn* it self, while it is in the *Egg*, would be unfruitful, was it to lie in deep *Water*. Again, as the young *Fish* grow bigger, they change their Station more and more towards the Deep, till they become of a fit Size to breed and produce others. It is rarely known, that in a good breeding *Pond* the *Fish* ever come to be very large; for the Number of them become so great, that they over-stock the *Water*, and are straitned for Food. I have been told, that where the shallowest part of a *Pond* is about two Foot in *Water*, that neither *Carp*, *Pike*, *Tench*, or *Perch*, will breed in it, because it is too deep for the *Spawn* to hatch, if the *Fish* should be enclined to lay any, and in such Places an ingenious Gentleman observes the *Fish* grow very large, and thrive a-pace,

pace. if they were at first rightly proportion'd to the Quantity of *Water*, and put in at a right Age. An Acre of *Water*, he tells me, (if all the Parts of the *Pond*, one with another, measure three Foot deep) may well enough bear ninety Brace of *Carps*, which is about a Rod of *Water* to each *Fish*; or else, as he observes, eighty Brace of *Carps* and twenty Brace of *Tench*, and so in proportion for every ten Brace of *Carp* wanting, he allows twenty Brace of *Tench*. These *Fish*, he supposes, delight to be together; and remarks, that the *viscous* Matter upon the Bodies of the *Tench* is often serviceable to such *Carp* has have by Accident been wounded. It is found by Experience, that both these Kinds of *Fish* thrive much better in old *Ponds*, than those that have been newly made; and he gives this Reason for it, That in a *Pond* newly cut or dug, the *Water* is not all of one piece, or partaking of the same Qualities, which it must have sufficient Time to draw from the Earth, and circulate through, or mix with every part alike of the *Water*; for he holds it as a Maxim, that *Fish* never thrive which have any Change of *Water*, after they are two Years old, and therefore always stocks his *Ponds* with Store of the second Year. To experience this, he told me, that in one *Pond* he put in at the same time *Carps* of the second Year, some of the fourth Year, and some of eight Years old, marking those of the two last Age: Five Years afterwards he drew the *Pond*, and found that the young *Fish* of the second Year were much larger than any of the others; which happen'd, as I suppose, for the same Reason that young *Plants* are more easily transplanted, and thrive much better, than elder *Plants* that have stood long enough in a Soil to be naturaliz'd to it; or that People, that have been bred up from their Infancy, and a long time breathed their Native Aire, grow sickly upon changing it; just so does the changing of *Fish* from one *Water* to another alter their Constitution. 'Tis likewise observable, that a Plantation of *Trees* too near a *Pond* is apt to infect the *Water* with

its falling *Leaves*; but, on the other hand, Shelter is necessary, and is much the best, as it consists of *Herbs* and *Plants* which naturally grow in the *Waters*, such as *Water-Lillies*, *Pond-Weeds*, and *Flags*, which breed and afford a great Number of *Insects* for the *Fish* to feed upon, and help to guard them from the too great Heats of the Sun; but chiefly I am told these *Weeds* are useful to *Pikes* and *Perch*, and that they are better fed *Fish*, and much larger in such *Ponds*, than where they have only a naked *Water*. The *Pike* being a *Fish* of Prey, will admit of no *Fish* to abide with it but the *Perch*, and that only avoids the voracious Appetite of the *Pike*, by means of the thorny *Furms* on its Back. In these *Ponds* however it is commonly practised to sling in a Parcel of *Roach* for the Food of the *Jacks*; and I knew a Gentleman, that thought it worth his while to stock his *Pike-Ponds* with *Frogs* for the same Use. These, as well as the *Carp* and *Tench*, may be fed with Blood and Bran mixt together, Raspings of Bread, or the Entrails of *Fowl* or *Sheep*; and if they are regularly used to be fed in this way, at a constant Hour and Place of the *Pond*, they will in a short time become undaunted, and feed before us, which is all I shall say at this time relating to *Pond-Fish*.



CHAPTER XVI.

Of the most curious GARDENS in Europe, (especially in Britain) and what may be learnt particularly from them; with some Remarks and Experiments relating to the Improvement of FRUIT-TREES and FLOWERS, never before made publick.

BESIDES the innocent Diversion which is found in a *Garden*, by cultivating many of the greatest Beauties of the Creation, Mankind may gain immediate Advantage, by reaping the *Fruit* of his Labours. The Health of the Body is moreover maintain'd or encouraged, if we give our helping Hand towards the propagating of *Vegetables*. A gentle Exercise in a fresh Air, where the Mind is engaged with variety of natural Objects, contributes to Content; and it is no new Observation, that the Trouble of the Mind wears and destroys the Constitution even of the most healthful Body. All kinds of *Gardens* contribute to Health; but every one is not equally advantageous or profitable. There are *Gardens* of Grandeur and Recreation, such as those of the inimitable *Versailles*, those at *Marli* and *Trianon*, belonging to the King of *France*; and in *England*, the Royal *Gardens* at *Kensington*, regulated by Mr. *Wife*, afford as many agreeable Varieties as any in *Europe*, where the Situation is flat, and the Command of Water is wanting. The *Gardens* at *Kensington* have not indeed the Extent of those which I mention in *France*, nor had the Director of them the Happiness to make them all at one time, but was content with giving now and then

a Beauty as Occasion offer'd. The Irregularities which I remember were in the Ground, when he took the last part of them in hand, has particularly signalized his Judgment; so that we are led to an Imagination of the Beauties that would have appear'd in them, if they had still been more irregular when he undertook them.

The Royal *Gardens at Hampton-Court*, under his Care and Direction, are famous for the Variety of *exotick Plants* brought from most Parts of the World, but more especially for the healthful Condition of them, and exact Symetry in the disposing them in their several Conservatories; and it is here that we have Example of *Orange-Trees* bearing plenty of *Fruit*, in as great Perfection as we can desire, which surpasses what I find at *Versailles*; so that we may judge how much the Skill of a Director is necessary to contrive and manage in such a Case; for tho' the *Trees* at *Versailles* are extraordinary large, and in great Numbers, they were without *Fruit* when I was there; so that I cannot enough commend the Ingenuity of Mr. *Archer*, who is the present Manager at *Hampton-Court* under Mr. *Wise*.

The *Versailles Gardens*, as they are of vast Extent, and have cost such Sums as perhaps no Country in *Europe* is worth; so it would be of little Use to describe their Particulars; but in general we may say this of them, that their Order and Contrivance has been as well Poetically as Mathematically study'd, each respective Part has a just Proportion with the History represented in Statues and Water which it contains; so that we never observe too many, or too few Statues, or more or less Water than the Imagination can expect, and so near Nature is the artful Contrivance of these *Gardens*, that we are led with Expectation and Desire throughout the whole; but we must still observe, that in this Wonder of a *Garden* there is neither *Grass-work* nor *Gravel*, nor the beautiful Ornaments of variegated *Hollies*, which is the Glory of the *English Gardens*.

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Was I to give a particular Description of our *English Gardens* for Pleasure, which the Curious, among our Nobility and Gentry, have brought to Order; a large Volume would not contain their Account. Some are happy in their Situation for *Cascades* and *Fet d'eaux*; others have their Beauties in agreeable Prospects; and so likewise was I to describe the *Gardens* of Particulars in *France*, we should find them abound in natural Beauties, and only wanting of those Ornaments in which we exceed most other Parts of *Europe*, viz, *Grass*, *Gravel*, and Variety of hardy *Ever-greens*. Again, the *Gardens* in *Holland* have very different Appearances and Modes from those in *England* and *France*; the *Holland Gardens* are not indeed without Water, but it is commonly such as is of no Use either for Water-works, or common Service to the *Plants*; for the Country is level, and the *Canal* Water commonly salt or brackish, so that I have often seen Boat-loads of fresh Water brought from a great Distance; but the *Canals* which encompass and bound the *Gardens* have a very good Effect, being assisted with the Ornaments of *China*, and gilt Pots and Vases, with Statues, and Arbours or Cabinets of *Lattice* Work, which together afford an agreeable Prospect; but *Holland*, no more than *France*, possesses the Beauties of fine *Grass-Turf*, or *Gravel*, or the Ornament of our *English Evergreens*; nor indeed is the Soil so natural to most *Herbs* of the *Kitchen-Garden*, as it is generally in *England*; which one may easily observe, by comparing the Produce of one with the other; but for bulbous *Roots* we find it to produce Wonders, which has given me occasion to consider the Nature of that Earth more particularly; it is composed of fine *Sea Sand*, with a Mixture of *Turf* or *peat Earth*, which seems to be two Thirds of the former, and one of the latter; and the Benefit of this kind of Soil in propagating bulbous *Roots*, has made the *Hollanders* famous, especially in *Tulips*.

Lately I have observ'd, that our *Heath Grounds*, which is most like the *Holland Soil*, yields very good *Saffron*, and even pro-

produces a better Crop than the *Chalky Soil* about *Saffron Walden*; upon the latter, an Acre of Ground, in its full Strength, brings about twelve Pounds of *Saffron* in a Season; but the *Saffron Roots* in the *Heath Ground* bring more *Flowers*, about one sixth part. 'Tis to be noted, that all the *Saffron Grounds* are subject to be destroy'd by *Hares*, and therefore are enclosed with *Hurdles*: And again, the second or third Years of planting those *Roots* give the greatest Crops; for they must be separated or transplanted after the third Year's bearing, or else they produce little. But to proceed.

The profitable *Gardens* are of three Kinds; first, those cultivated for *Kitchen Uses*; secondly, the *Nurseries* for Improvement of *Timber, Fruit, &c.* and those which are disposed for the Use of *Physick*, and are the *Seminaries* and *Nurseries* of *exotick Plants*.

The first, which are *Kitchen Gardens*, and exceed all the other *Gardens* in *Europe* for wholesome Produce, and Variety of *Herbs*, are those at the *Neat-Houses* near *Tuttle-fields, Westminster*, which abound in *Salads*, early *Cucumbers, Colliflowers, Melons, Winter Asparagus*, and almost every *Herb* fitting the Table; and I think there is no where so good a School for a *Kitchen Gardener* as this Place; tho' *Battersea* affords the largest natural *Asparagus*, and the earliest *Cabbages*. Again, the *Gardens* about *Hammer-smith* are as famous for *Strawberries, Raspberries, Currants, Goosberries*, and such like; and if early *Fruit* is our Desire, Mr. *Miller's* at *North-End*, near the same Place, affords us *Cherries, Apricocks*, and Curiosities of those Kinds, some Months before the Natural Season. I could mention several particular *Gardens* about *London*, where I've found an Excellency in the *Gardeners* belonging to them; but as there are Accidents which happen every Day that may occasion the Removal of the *Artists* from those Places, it will be of little Use to name them in this Work, but rather take notice of the Famous among them
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in some other Treatise, where I may have a better Opportunity of setting forth their several Merits.

The *French* in their Kitchen Gardens propagate *Mushrooms* in large Quantities; and indeed about *Paris* the Gardens are chiefly employ'd in this way, so that the Markets are plentifully stored with them at all Seasons in the Year; and I have often wonder'd, that yet none of our *English* Gardeners take up that Business, considering the Profit which would accrue to them from such an Undertaking: If they are still without Knowledge of the Method of raising them, they may see the Direction in the second Chapter of this Work. For the rest of the *French* Kitchen Gardens, they have little more than *Herbs* for Soup and Salads, almost like those in *Holland*.

The next Degree of Gardens for Profit, are the Nurseries of Forest-Timber and Fruit-Trees; the chief for the first sort, are those about *Ipsleworth*, *Twittenham*, and *Brentford*, which abound in those necessary and useful Commodities. Mr. *Parker* at *Strand on the Green*, and Mr. *Green* of *Brentford*, raise yearly vast Numbers of every kind of Tree which is proper for the Improvement of Land. Nor are the Gardeners of this Nation less curious in cultivating of *Fruit-Trees*; so that I esteem the Collections we have now in *England* to exceed all the Nurseries in *Europe*, for profitable and useful Varieties; particularly that curious Garden of Mr. *Thomas Fairchild* at *Hoxton*, where I find the greatest Collection of *Fruits* that I have yet seen, and so regularly disposed, both for Order in time of ripening and good pruning of the several Kinds, that I do not know any Person in *Europe* to excel him in that particular; and in other Things he is no less happy in his Choice of such Curiosities, as a good Judgment and universal Correspondence can procure.

The curious Mr. *Green* at *Brentford* has also signalized himself in the Culture of some *Fruits*, and particularly the Pruning

and Ordering of *Figs*, which are by his Method much forwarder, and in greater Quantity than I observe elsewhere in *England*; he has also cultivated in *Espalier* the *Bruxelles Abricots*, which affords a profitable Crop; but yet in the most perfect *Gardens* which I have observ'd in *England*, I am surpris'd that I have not found any Variety of *Figs*, exceeding the old Set of the *Blue Fig*, the *Early White*, the *Long White*, and one other Kind; for if we pass but over to *France*, we find at least fifty different sorts of *Figs*, which afford as much Variety to the Taste, as the *Peaches* or *Pears* we have upon our Lists. There is one *Memorandum* I cannot avoid inserting in this Place, relating to the different Kinds of *Fruit*, which at present croud the Nurseries; were we to take all the sorts we have Names for, we should despise the greater part; and I believe, from what I have observ'd abroad, that there are no better *Fruits* there than we have already among us, because I find little difference between the Lists of our Nurseries, and the *French* Lists that are sent over every Year from *Orleans*. For my own part, I have remark'd, that in *Devonshire*, *Herefordshire*, and some other Parts of *England*, the Seedling *Plants* rais'd from the *Kernels* of *Pears*, *Apples*, &c. continually afford Varieties of *Fruit*, very different from what we gather from those *Plants* we had the *Seed* from. My curious Friend, *Samuel Reynardson*, Esq; of *Hillingdon*, near *Uxbridge*, has likewise rais'd several new Kinds of *Peaches* and *Grapes* from the *Stones* or *Kernels*; so that I see little Necessity for seeking out Varieties of *Fruits* in foreign Countries.

The third sort of profitable *Garden* is the *Physick Garden*, where, besides the Collection of *Herbs* used in Medicine, we commonly find some Variety of such exotick Rarities from the hotter Climates, as afford the Curious sufficient matter of Admiration. The first *Garden* of this kind that I have yet seen, is that at *Amsterdam*, which altho' it is not of great Extent, yet
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it affords the greatest Choice of valuable *Herbs* and *Plants*, agreeable to its Design, of any *Garden* in *Europe*. The Method of it is the Classing of *Plants* in several Beds appointed for that purpose; upon which, the famous Professors, Drs. *Comellin* and *Ruysh*, read to the Citizens twice every Week; the first, upon those which are *Exotick*, and the latter on the *Domesticks*. The Governours of this *Garden* are the Chiefs of the City, who have a Delight in making it a Nursery of such *Plants*, as the Trade of their Country will give them leave to transport from the *East* to the *West Indies*. An Instance of which is, that in the Year 1714, when I was there, they rais'd a considerable Number of *Coffee Trees* from *Seeds*, which ripen'd at *Amsterdam* upon two *Plants* that they first sent from *Africa* to *Batavia*, and from thence to *Holland*; from whence they transported them to *Surinam* and *Curasau*, supposing they might one Day bring forth profitable Crops that would yield Advantage to their Country; for these Places are so situate, that the Voyage to them is not a fourth of that to the *East Indies*, or a third to the *African Coast*, where *Coffee* grows: and if ever the *Dutch* should lose the Eastern *Coffee Trade*, or their *East Indian Plantations*, I expect that Drug will be chiefly brought to us from the *West Indies*, where the *Hollanders* have planted it. 'Tis to the *Amsterdam Physick Garden* I owe the greatest Part of that Collection of Curiosities which I once glory'd in; and to judge from what *Gardens* I have seen in *Europe* of this Order, I must do the *Amsterdam Garden* the Justice to own, that it exceeds all others in Variety of Curious and Useful *Plants*, from every Quarter of the World.

The next to the *Amsterdam Garden*, is the *Royal Garden* at *Paris*, where we may observe the Medicinal *Plants* ranged in exact Order, by the learned Dr. *Antoine de Jussieu*, the King's Professor of *Botany*. We find there likewise a good Collection

of *Exotick* Curiosities disposed after a good manner, and managed with excellent Skill; from whence I likewise drew several *Plants* that had not been seen before in *England*.

The *Physick Garden* at *Leyden* is what we may admire in the next place, for its good Order, and Variety of foreign *Plants*, under the Direction of the celebrated Dr. *Boorbave*. It is here I have found the greatest Quantity of that extraordinary *Jessamine* of *Arabia*, whose *Flowers* excel all others in their Odour.

Among the Foreign *Physick Gardens*, I might yet mention that at *Pisa* in *Italy*, and the *Gardens* at *Florence* belonging to the Grand Duke of *Tuscany*; from whence, by his Royal Highness's Direction, I have receiv'd valuable Presents of choice *Plants*, rarely to be found in other *European Gardens*.

In *Britain*, our regular *Physick Gardens* are not above three in number; the best of which is that at *Chelsea*, belonging to the Company of *London* Apothecaries; where we may observe a great Variety of such *Plants*, as are useful and entertaining to the Curious, as well *Exoticks* as *Domesticks*: And after this, the *Physick Garden* at *Oxford* takes place in Reputation, from the Skill of the late learned Professor Mr. *Jacob Bobart*, who had the Management of it. The *Physick Garden* at *Edinburgh*, according to the Account I have of it, is valuable for the Collection of useful *Plants* in Medicine; but I doubt the Climate in that Country is hardly generous enough to encourage the Growth of such *Plants* as are Natives of the warmer Parts of the World.

To these we may add the curious *Gardens* of Particulars, which are famous for their Varieties of valuable *Plants*; the Chief of which in *England* are those at *Badminton*, whose Rarities were collected by that incomparable Lady the Dutchess of *Beaufort*. The *Gardens* belonging to *Samuel Reynardson*, Esq;

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at *Hillindon*, near *Uxbridge*; and the Collection at *Mitcham*, raised by *Mr. Du Bois*; and at *Cheame* in *Surrey*, by the Care and Skill of that excellent Flowrist the Honourable *Lumley Lloyd*, D. D. with which we must also mention that numerous Collection made by the ingenious *Mr. Tho. Fairchild* at *Hoxton*, from every one I have yet named, both at home and abroad.

This is the Sum of our *English Gardens* for Curiosity, not to mention my own Collection, which, with more than ten Years Pains and Expence I got together; which is enough to support the Spirit of *Botany*, and to which every Lover of that Science ought to address himself, for his Satisfaction in the Knowledge of *Plants*.

But to make good the Title of this Chapter, I come now to speak of *Fruit-Trees*; and first of all of the *Orange*, which this Year my worthy Friend *Mr. Curtes* of *Putney* has treated in a very particular manner, and has had that Success, that I have learnt it is possible to have a grafted *Tree* or *Plant* of that kind in five or six Months, from the *Seed* or *Kernel*. I have observ'd in another Work, that the *Seed* of a *Lemon* will produce a *Plant* much more vigorous than that of an *Orange*, in the same space of time; and therefore the curious Gentleman above-named used *Lemon* Stocks, rather than those of *Oranges*; but not more than four Months from the *Kernel*, he cut the tender *Stems* of these Horizontally, about half an Inch above the *Ear-Leaves*, and slit it down about half an Inch, as in the Figure; and that his Design might be agreeable to the Laws of Nature, he prepared *Cions* of good bearing *Trees*, which were then tender in shoot, and conformable to the Strength and Age of the Stock, so as to answer the Bigness of it; and pruning the Lower End Wedge-wise, fix'd it in the prepared Stock, and tied it with Worsted, which takes little room, and is subservient

servient to Variety of Weather, by stretching or shrinking, as the Air alters its Property; over this Binding he puts a small Quantity of grafting Wax, and in a few Days the *Stock* and *Cion* are join'd, and become as much one Body as other *Grafts* and *Cions* will do in two Months. As this will do in *Orange-Trees*, I doubt not but every other kind of *Fruit* may be as easily propagated, and then we should enjoy this Satisfaction, that where a *Bud* or *Graft*, in the common Case, is hard to be got, we could answer our End as well by a tender growing Shoot. But the Excellency of this Discovery seems to open a new Field of Knowledge, which I shall examine into hereafter.

In the next place I come to enquire into the common Complaint of those Gentlemen, who wait with Impatience for the bearing of the *Fruit-Trees* they have planted; and for that Reason I have contrived a Method, which I think will be satisfactory to them; and whereby there is not any Month in the Year, in which they may not plant their *Gardens*, but especially their Walls, with any *Fruits* they desire, by which Means they will not only gain two or three Years time, but may even bring their *Trees* into their *Gardens* with *Fruit* upon them, and so be satisfied they possess the Varieties they desire.

To do this, I have engaged some Nursery Men to provide a large Number of Boxes, whose Frame and Sides may be taken to pieces at pleasure, each of these Boxes to measure eighteen Inches over, and as many in depth; in these I advise a Set of *Fruit-Trees* to be planted, of the best Kinds, and train'd up in the same manner that we use to those *Trees* which are planted against Walls, giving them their regular Pruning from time to time, and directing their *Branched* and *Twigs* in the Posture they ought to lie upon *Espaliers* made of *Arbour-poles*: When these *Trees* are brought to bear, we may transport them to any Distance with their Cases, without injuring them; and be it at
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Fig. I.

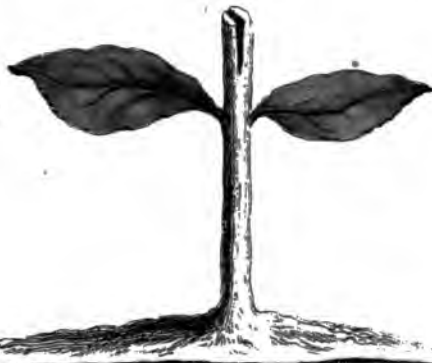


Fig. II.

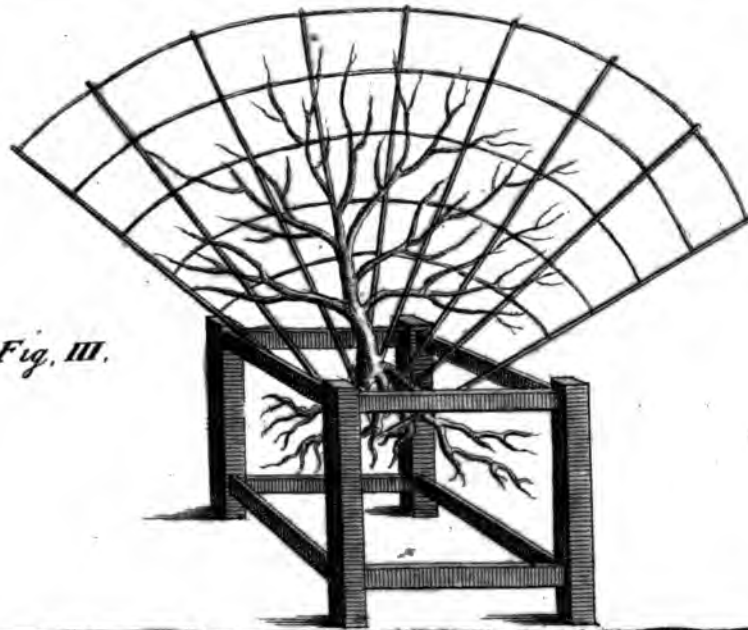


Fig. III.

what Season it will, they may be set into the Ground at once, with their whole Clump of Earth, and without receiving any Injury. In this Operation, Care must be taken in taking off the Cases, that the Clump of Earth is not crack'd or broken, least the Air get in; the Bottom-board therefore must be interr'd with the *Tree*, and the remaining Parts of the Cases may serve again.

To conclude this Chapter: I recommend the raising of all sorts of *Flowers* from *Seeds*; and, I think, there can be no greater Motive to encourage our Gardeners to this Undertaking, than directing them to Dr. *Lloyd's* of *Cheame*, Mr. *Dunklyn's* at *Clapham*, and my Friends Mr. *Greenhill* at Mr. *Hunt's* in *Putney*, and Mr. *Fairchild*, where they may observe wonderful Collections of *Flowers*, viz. *Ranuncules*, *Bulbose Iris*, &c. lately raised from Seminaries discreetly made by those Artists.

Explanation of the Plates relating to this Chapter.

Fig. I. *A Cion cut from a tender Shoot of the Orange-Tree, which is the youngest Sprout that could be cut from thence.*

Fig. II. *A young Lemon Plant in its first Growth, when the Ear-Leaves are upon it, agreeable to the Age, Strength, and Bigness of the Graff.*

Fig. III. *A Fruit-Tree planted in a Case, and trained up in Espalier, so that it may be planted aganst a Wall at any Season; even in Flower or Fruit, in the Situation we desire, without injuring the Tree; design'd for the Advantage of such as cannot plant their Gardens at their own time. In this Figure the Case is so contriv'd, that it may upon this Occasion be taken to pieces, and return'd to the Place it came from, without doing Hurt to the Plant.*

C H A P. XVII.

Of VINES, the best Method of Pruning them; with some proper Hints for such as delight in raising forward FRUITS.

ALTHO' I have treated of the Culture of *Vines* in another Work; the Opportunities I have had since of making Observations on the Management of *Vines* in *France*, gives me Occasion to mention some Improvements which are pleasant and profitable, and may greatly forward the Ripening of that delicious *Fruit* in *England*.

It is observable, that every *Vineyard* in *France* chiefly depends on the *Fruit* produced by Annual Layers; for the *Fruits* they bear are much larger, and ripe earlier, than what we find growing upon the old *Stocks*, whose greatest Use is to yield *Branches* for the Layers of another Year. This leads us to judge of the Method of managing our Wall *Vines*, and directs us to preserve the young Wood for the sake of large and good *Fruit*. It is therefore improper to build an high Wall for *Vines*, because all old Wood should be taken away, and the most Vigorous of the young *Shoots* left at due Lengths for a Crop; and in this case we must have regard to the Substance of the Wood we preserve: A *Branch*, for Example, whose Diameter is about half an Inch, may be left a Yard long; a *Branch* of one third of an Inch in Thickness, about two Foot; and so in Proportion; and at the same time, in convenient Places, two or three *Buds* must be kept to supply *Branches* for the following Year.

This

This Summer I consider'd further of the Method of raising *Vines*; and among many Experiments I made, I found one, which, I think, will be of extraordinary Use, by giving us that Satisfaction which we have long wanted, of planting Sets, or Cuttings of *Vines*, all the Summer Season; so that where we are sure of a *Grape* we like, we may at any time propagate as many of that sort as we please.

In *May*, which is the Month when those Gardeners who have pruned unskilfully, are obliged to dismember their *Vines* of the crouding *Branches*, which begin to bud out, we may plant every *Shoot* they pull off with the same Success that we are used to make Nurseries of 'em in *November*, *December*, or any of the Winter Months. In this Practice we must cover the Part that is to be interr'd with common soft Soap; and from a *Shoot* thus managed, we are sure of a strong *Plant* before the colder Seasons reach us, as I have experienc'd. By this Method we learn two Things, first, that Soap is of excellent Use to the Improvement of the Growth of *Vines*; and in the next place, that we may gain a Year by this new Discovery: And from the whole I gather thus much, that Soap is the best Manure for *Vines* in general.

I next come to describe those Methods now in Use for producing of forward *Fruits*, by means of artificial Heats, such as *Coal* or *Wood-Fires*, or *Horse-litter*. The first is by building Ovens at certain distances at the Back of the Walls, and keeping them continually warm, from *January*, till the Sun's Power is sufficient of it self to maintain the Growth of the *Plants* growing against such Walls, as it is now practis'd at his Grace the Duke of *Rutland's*, at *Belvoir Castle*, whereby the latest Kinds of *Grapes* are commonly ripen'd about *July*, or *August*; but in this Method we must likewise take notice, that during the cold Season, when these *Fruits* are forced to shoot unseasonably, the *Plants*

must be cover'd with Glasses, to prevent the Injuries they might receive from Frosts.

But the Method which Mr. *Millet* takes to force *Cherries*, *Abricots*, and some other Kinds of *Fruit*, I take to be much the cheaper way, which is by building a Pale of five or six Foot high, composed of Deal-boards an Inch thick, closely jointed, on the South of which he nails his *Trees*; and about *December* lays a Coat of Horse-Dung to the Back, about three Foot thick at the Base, sloping, to about a Foot and half at the Top, which for about six Weeks strikes a Warmth thro' the Boards, so agreeable to Vegetation, that the *Plants* blossom and dispose themselves to bear *Fruit* in great Abundance. Here I must observe, that when the Weather is moderate, he gives them what Air he can, by properly opening the Glasses which stand before them; and that when the Litter at the Back of the Pale has lost its Heat, he renews it from time to time, till the Season becomes natural to the Growth of *Trees*.

Having given my Readers what I at first propos'd, *viz.* *A Philosophical Account of some Works of Nature*, in the *Mineral*, *Vegetable*, and *Animal* Parts of the *Creation*, in as many Instances as Time would admit for the necessary Experiments, &c. I am now to inform them, that as this Essay shall give Satisfaction, and the Author receive Encouragement in his Undertaking, more of his Time shall be employ'd towards carrying on a Work so useful to Mankind, which, by degrees, may frame a general and compleat Body of Experimental Natural Philosophy.

F I N I S.

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